Included are the four information bulletins produced by the ERIC Clearinghouse for Science, Mathematics and Environmental Education for the calendar year 1980. The first issue contains an interpretative summary from the National Council of Teachers of Mathematics project "Priorities in School Mathematics" as well as announcements of recent ERIC/SMEAC publications in mathematics education. The second issue contains descriptions of materials on energy-related careers and announcements of recent ERIC/SMEAC publications in environmental education. The third issue is focused on information related to the topic of safety in the science classroom. Safety is discussed as it relates to teacher responsibility, general safety procedures in the science laboratory, and safety procedures for the use of chemicals, microorganisms, plants and animals, electricity, lasers, and model rockets. The fourth issue summarizes activities of the ERIC system in general and ERIC/SMEAC in particular and highlights nine ERIC/SMEAC documents in the form of expanded descriptive abstracts of each document. (Author/JN)
An Interpretive Summary from the NCTM Project

"Priorities in School Mathematics"

Editor’s Comments

This issue of the ERIC/SMEAC Information Bulletin features a national survey conducted to determine preferences and priorities for school mathematics for the 1980’s. The study was directed by Alan R. Osborne and others for the National Council of Teachers of Mathematics, Inc. and was funded by the National Science Foundation. The description of the study’s findings was written by Gary Sweitzer, Graduate Research Associate and Information Analyst for Science Education, ERIC/SMEAC, and was based on reports prepared by Jon L. Higgins, Faculty Research Associate — Mathematics Education, ERIC/SMEAC. Dr. Higgins was one of the individuals involved in conducting the Priorities in School Mathematics (PRISM) project.

The final report on the project and appendices to the report are available from ERIC Document Reproduction Service (EDRS), P.O. Box 190, Arlington, VA 22210. The final report and appendices A and B are ED 184 891. Appendices C and D are ED 184 892. Persons wishing to obtain copies of this material should use an order form found in the back of an issue of Resources in Education (RIE) and should send it to EDRS. This material is not available from the ERIC Clearinghouse for Science, Mathematics, and Environmental Education.

Introduction

The PRISM study (Priorities in School Mathematics) was designed by the National Council of Teachers of Mathematics to help provide guidelines and suggestions for mathematics curriculum changes during the 1980’s. The study contained two major components. The first of these (the preference study) presented a wide range of alternate content topics, instructional goals and methods, and teaching resources for the K-12 mathematics curriculum. Survey respondents were asked to identify their preference for the alternatives within the context of nine major areas (strands) of the mathematics curriculum. These strands were identified as follows: problem solving; computer literacy; whole numbers; fractions and decimals; algebra; measurement; ratio, proportion, and percent; geometry; probability and statistics.

The second component of the PRISM study assessed priorities for mathematics curriculum change and development. Respondents were asked to judge the relative importance of curriculum alternatives against each other. These data identify points in the mathematics curriculum where change is needed or most desired.

Although there are many theoretical bases for making curriculum decisions (both mathematical and psychological), the final implementation of curriculum change depends upon the individual preferences of teachers, administrators, and parents at the local school level. The PRISM study represents the first systematic attempt to assess these preferences and priorities before recommending curriculum development and change. Knowledge of current attitudes and preferences can be useful in predicting which curriculum changes may be readily adopted and which may meet with resistance. It does not, of course, provide information about the usefulness of the suggested alternatives, nor does it in any way limit the development of additional alternatives.

Many groups of people are involved in successful curriculum change, and the pattern of progress and failure depends upon agreements, disagreements, and interactions among these groups. The PRISM study identified nine such groups and contrasted preferences and priorities among them. Four groups of teachers were identified. Elementary and secondary teachers with particular interest in mathematics were sampled from subscribers to the NCTM publications the Arithmetic Teacher and The Mathematics Teacher. Junior college and college mathematics teachers were sampled from members of appropriate professional organizations. Teacher educators were also identified as an important group in implementing curriculum change, and were also sampled.

Alternatives Within Strands

Problem Solving

Both professional and lay populations agreed on problem solving as a focus for the mathematics curriculum of the 1980’s. More respondents indicated that curriculum emphasis on problem solving should be increased than for any other area. Over 95% identified the goal of problem solving as the development of methods of thinking and logical reasoning. Other goals that were strongly supported include the acquisition of skills necessary for living in today’s world and techniques that are vital to having a well-rounded education.

Three problem-solving techniques that might be taught to students were strongly supported at both the elementary and secondary levels. These were: construct a table and search for patterns, translate the problem into number sentences or equations, and write and solve a simpler problem—then extend the solution to the original problem. Although there was moderate support for guessing and testing possible solutions, a suggestion that students generate many possible answers using a calculator or computer and then check to see which one meets the conditions of the problem was not supported. Respondents did give moderate support for having computers and hand-held cal-
calculators available for problem-solving work, but it was not apparent from survey results just what they would do with them.)

Problem solving also received strong endorsement from PRISM respondents as the top priority for development of new materials at the elementary school level. Respondents noted that problem solving is a crucial skill for students and a major area of difficulty for teachers. Strongest support was given to the development of a resource guide to real-life problems, materials for modeling problems and problem solutions, and supplementary materials which contain many more problems like those in textbooks. Very strong support was also given to inservice training on problem-solving methods for all teachers who teach mathematics.

Computer Literacy

Substantial agreement and support across samples on the rank ordering of goals for computer literacy was apparent with over 80% identifying the development of logical thinking abilities and preparation for the future as important goals. The idea that knowledge of computers is only needed by specialists was strongly opposed (by 88.9%). Support for developing computer literacy topics for all students was second only to support for mathematical applications. More than 80% of those sampled believed that the computer literacy topics should include flowcharting, writing programs in a simple computer language such as BASIC, operation of a programmable calculator, and learning about the roles of computers in society.

Problem solving was also a strong focus for computer literacy, with more than 50% rank ordering the ability to solve problems. Agreement was sought in those fields that computer literacy topics should be taught the types of mathematical and non-mathematical problems that can be solved by a computer. (Interestingly, including in mathematics courses issues of privacy and security raised by computers was given only moderate support.)

While there was substantial agreement on computer literacy goals, there was not strong consensus on the teaching strategies to accomplish those goals. Field trips for student observation of computer systems and individuals, student projects for the study of computer applications and their impact received the most support, but it was moderate.

When respondents were asked to assign priorities to the development of new instructional materials at the secondary level, they gave first priority to materials for computer literacy (over those for algebra, geometry, statistics, and probability). A course that helps students understand how calculators and computers handle mathematics was their second choice out of five possible courses that should be added to the high school curriculum.

Whole Numbers

Respondents recognized both practical and theoretical goals for learning whole number computation. Top-ranked by all but the college mathematics teacher sample was acquisition of skills necessary for consumer decisions. Ranked only slightly lower was the goal of developing fundamental understandings upon which other mathematics learning is built (this goal was top ranked by the college mathematics teacher sample.) Other goals strongly supported were the development of logical thinking ability, understanding of the structure of mathematics, and the acquisition of qualifications for obtaining jobs.

Seventy-two percent of the respondents to the whole numbers portion of the questionnaire agreed that a calculator should be available for every student. But 91% felt that every student should master whole number computations with paper and pencil before graduating from high school. Similar percentages held that techniques of estimation and mental calculation (without the aid of paper and pencil) should be taught. Other whole number content supported included specific strategies for solving word problems, mathematical puzzles and games, developing operations simultaneously, and the teaching of specific consumer skills such as balancing a checkbook or computing best buys. Specific uses of a calculator were limited to checking answers, adding the cost of several items in a grocery cart, or doing a chain of calculations involving different operations and the paper-and-pencil algorithms for them. Using a calculator to learn basic facts was opposed by 57%; use for calculating change from a five dollar bill was opposed by 65% and using a calculator on a whole number computation test was opposed by 78%. Thus while acknowledging that children should have calculators, respondents would make limited use of them and would continue to stress paper-and-pencil and mental arithmetic.

There was general agreement across samples on the inclusion of four resources for teaching about whole numbers. These materials were identified as resource books compiling examples of arithmetic applied to real-life situations, masters of worksheets and activities, standardized practice tests, and packaged materials for individual study.

Fractions and Decimals

Fractions will continue to play an important role in the mathematics curriculum of the 1980's. Almost 90% of the professional samples opposed omitting fractions entirely from the curriculum. A similar percentage disagreed with the suggestion that only college-bound students be taught fractions. A suggestion that all students should master operations with decimals, but not all should be expected to master operations with fractions, was opposed by 60%.

The most strongly supported goal for both fractions and decimals was that they were used in many vocations such as auto mechanics, carpentry, plumbing, etc. Vocational practicality seemed to be particularly dominant theme for decimals. The second- and third-ranked goals for decimals were that consumers need decimals for computing "best buys" and that decimals are used in money. On the other hand, respondents clearly opposed introducing decimals by relating them exclusively to money. Instead, the indication was that decimals should be developed as a means of naming numbers between numbers.

There is some evidence that respondents attach more importance to decimals than to fractions. Approximately 86% would give increased emphasis to decimals during the 1980's, but only 44.1% would give increased emphasis to fractions. When asked to rank five elementary content areas as to the priority for developing new curriculum materials, decimals was ranked second (behind problem solving), while fractions was ranked last. Minimal support (55.3%) was given to the idea that more attention should be given to operations with decimals than operations with fractions. But responses were fairly evenly divided to the suggestion that operations with decimals be included in the first- or second-grade mathematics program (the most opposition came from the mathematics supervisor, teacher, educator, and lay samples).

Moderately strong support was given to presenting fractions as answers to division problems (e.g., 6/12 means 6 divided by 12). In contrast, only minimal support was given to developing fraction models (e.g., using circle patterns). (The most minimal suggestions were made separately for elementary level and for secondary level—responses were essentially the same at both levels.)

The resources most desired for teaching fractions and decimals were drill and practice materials, masters of worksheets and activities, resource booklets with applications, and individual study materials. In contrast, the desire for student sets of measuring devices and for manipulative materials ranged from ten to twenty percentage points less. Respondents were satisfied with a relatively abstract approach to fractions. Despite the abstractness of this approach, more than 75% opposed the suggestion that work with fractions should be delayed until seventh or eighth grade. One concession was made: 75% agreed that students should be taught fractions with small denominators useful in various vocations. Support of this item was particularly strong from the mathematics supervisor and teacher educator samples.'
generally opposed, as were vectors, vec-
topics from introductory calculus were
dude for the general collegebound
algebraic topics those they would in-
ior college and college mathematics
lems, and inequalities. Writing equations to solve word prob-
alizations about numerical patterns,
strongly supported: solving open
four were very
ples were asked about including algeb-
tbooks for years, and would include
the list of topics to be taught to all stu-
textbooks at that level under the name of
programs, sequences and series, finite
ystems at the elementary level was op-
ted at the secondary level by the
Teaching of conversion was also op-
increased emphasis on the metric sys-
lie for teaching the metric system at both
elementary and secondary levels. Nearly
73% of the survey respondents favored
increased emphasis on the metric sys-
ience for how this should be ac-
There was moderate support (63.6%) for considering the mastery of percent
problems as a condition for high school
and less support (56.4%) for devoting more curriculum time to ratio
and proportion.
The practical inclination of the res-
spokes continued in their selection of
desired resources. Over 93% of
the respondents selected resource books of
applications of ratio and percent to real-
problems.

Geometry
What are the reasons for teaching
geometry? Survey respondents chose
reasons from a list containing both clas-
sical statements (e.g., to develop logical
thinking abilities) and practical state-
ments (e.g., to develop job-oriented
skills). They strongly preferred the clas-
sical statements, including the general
goal “to acquire knowledge for further
study.”

All survey samples supported the introd-
cution of geometry before seventh grade.
In fact, 65% felt that intuitive geometric
concepts were at least as important in
grade one as number concepts. The ad-
jective “intuitive” is very important in
this statement, however, since there was
strong opposition to the use of axioms,
proofs, or “logical reasoning principles”
anywhere in elementary school
geometry.

Survey respondents apparently be-
lieved that work in geometry should be
required of all pupils after seventh
grade, since they indicated that the pre-
sent geometry taught to elementary
schools was not an adequate minimum
knowledge for high school graduation.
But respondents had no clear prefer-
ence for how this should be ac-
complished. The junior college and
college mathematics teacher samples, as
well as the teacher educator sample,
tended to support increasing the portion
of the seventh- and eighth-grade cur-
riculum devoted to geometry. But the
Arithmetic Teacher and The Mathemat-
ics Teacher samples and the lay samples tended to oppose this idea. Apparently these groups still preferred a traditional separate geometry course somewhere after grade seven. Indeed, all samples opposed the suggestion that it be delayed until after students had two years of algebra. (The college mathematics teacher sample was particularly opposed to this suggestion.) One should thus note a traditional pattern of preferences emerging with respect to geometry: introduction of intuitive geometry in elementary schools, culminating in a separate geometry course probably placed between Algebra I and Algebra II.

This pattern of traditional preferences was confirmed when one examines preferences about specific geometric content. Topics most strongly preferred for elementary school geometry were properties of triangles and rectangles, parallel and perpendicular lines, symmetry, and similar figures. Responses were much the same for topics that should be studied by all students at the secondary level. Preferred were properties of triangles, rectangles and circles, similar figures, and coordinate geometry.

Respondents were asked about including in elementary schools such non-traditional topics as vector geometry, projective geometry, spherical geometry, and tessellations. Responses were equivocal in all cases, with no clear patterns of support or opposition emerging. But there was clear opposition (by all respondent samples) to the inclusion of finite or non-Euclidean geometries, and moderate opposition to the inclusion of tesselations and symbolic logic.

Survey respondents were also asked about geometry topics for the college-bound student who would not be a science or mathematics major. Apparently they would require only a very few advanced topics, since only coordinate geometry and straightedge-and-compass construction were strongly preferred. On the other hand, the availability of a full year course in applied geometry was supported by all samples. Since few specific topics were supported, this may indicate the appeal of applications for all areas of the mathematics curriculum.

Respondents at all levels expressed a preference for a resource-rich environment for teaching geometry. While the highest support was for resource books, short films and videotapes, and worksheet and activity masters, other items with over 65% support included indirect vision/study—materials—demonstration models, manipulative materials and laboratory experiments, measuring tool kits, 35mm slides, and computer-generated animated graphics.

**Probability and Statistics**

Almost 84% of the respondents agreed that the importance of probability and statistics was in applications mathematics to other disciplines. Nearly 95% agreed that the goal of probability and statistics is to enable students to read and think critically about graphs and data in other subjects such as science or social science. Indeed, the resource for teaching probability and statistics which received the strongest support was resource books with applications and problems (90.8%). Materials that include many examples of real-world data were supported by 94.3% and the use of problems that arise in the social or natural sciences to extract and develop concepts was also supported. Over 86% of the respondents supported the idea that students should perform experiments with dice and cards and study games of chance. On the other hand, there was only moderate support (53.1%) for providing students with ready-made data bases from previously completed experiments. The junior college mathematics teacher sample was particularly strong in their support of experiments and laboratory equipment for probability and statistics.

Development of new curriculum materials for probability and statistics during the 1980’s was not given high priority by PRISM respondents. When asked to assign priorities to the development of new materials for secondary schools in five curriculum areas (including computer literacy, algebra, and geometry), statistics was ranked fourth, and probability was ranked last. Strongest support for statistics and probability came from the mathematics supervisor sample. Statistics (but not probability) was also supported by the teacher educator sample. Opinion seems to support an elective high school course in probability and statistics (76.9% support), but not a required course. Almost two-thirds of those sampled opposed requiring a probability and statistics course for all ninth graders.

The integration of probability and statistics topics into regular mathematics courses was another matter, however. Nearly 70% of the respondents agreed that ideas from probability and statistics should be included in every mathematics textbook from grades one through eight. When asked specifically about topics for elementary students, strongest support (above 85%) was given to the collection and organization of data and to reading and interpreting statistical information. Decision-making and measures of central tendency were moderately supported. (These four topics were also endorsed as suitable for all secondary students.) Probability topics such as predicting outcomes and calculating the probability of an event occurring were also given moderate support for elementary students (76.1% and 63.6%, respectively). At the secondary level probability distributions, combinations and permutations, calculating probabilities of compound and conditional events, and curve fitting and prediction were supported as appropriate for college-bound students, but not for all secondary students. This may explain why the development of materials for statistics was given a slightly higher priority than the development of materials for probability.

**Alternatives Across Strands**

Respondents were asked to list the order in which five areas should be started in developing methods and the 1980’s: improved mathematics content for textbooks, development of materials for students with special needs, improved preservice and inservice education, development of non-text materials, and improvement of teaching methods and techniques. The area given highest priority by all professional samples was preservice and inservice education. The sample drawn from school principals ranked preservice and inservice education second, only behind the improvement of teaching methods and techniques. However, the school board and PTA president sample ranked teacher education fourth of the five areas (ahead of only non-text materials). Their first choice, like the principal sample, was the improvement of teaching methods.

**Teacher Education**

PRISM survey respondents believed strongly in teacher education. When asked to compare fifteen methods for attacking problems in mathematics education on the basis of general importance, practicality, and efficiency, inservice education was rated first and preservice education was rated second. The samples drawn from school board members and PTA presidents (SB/PT) tended to see inservice education as more important than preservice education, but this happened because they rank methods over which they are apt to have local control (e.g., grants to local schools) higher than methods that are more removed from their immediate influence.

Improving teaching methods is very compatible with preservice and inservice education, and can even be considered a goal of preservice and inservice education. Other possible teacher education goals included further knowledge of mathematics content, development of teaching materials, development of sensitivity to student needs, and knowledge of diagnostic and remediation strategies. When asked to rank these five areas (goals), methods for teaching mathematics was clearly the first choice for all samples except the SB/PT sample. This sample ranked methods second to sensitivity to student needs. There was a favorable reaction to sensitivity to stu-
dent needs. There was a favorable reaction to sensitivity to student needs by the Arithmetic Teacher, supervisor, and principal samples as well; only The Mathematics Teacher and teacher educator samples reacted negatively to it. The opposite pattern was in evidence on the reactions to knowledge of mathematics content, however. The Mathematics Teacher and teacher educator samples reacted positively to content, all other samples tended to react negatively. The supervisor sample reacted more positively to the area of diagnosis and remediation than did any other sample.

There was broad and general support for both preservice and inservice teacher education, and there was a definite preference for teacher education work to be focused upon teaching methods. Other areas of teacher education had different champions among different survey samples.

Curricular Approaches

Mathematics has traditionally been viewed as a discipline which "teaches people how to think." This view is not likely to change during the 1980's. Developing logical thinking ability as a general goal for mathematics received very strong support (over 93%) from all survey samples. Developing logical thinking ability as a goal for whole numbers, geometry, and probability and statistics received very strong support (over 90%) from most professional samples; as a goal for computer literacy, support for logical thinking was only slightly less (80%).

Apparently the desire of most respondents was to treat logical thinking indirectly rather than specifically. Symbolic logic as a topic for all students received very little support (31%). It did receive minimal support for college-bound students who will not be mathematics or science majors. There was very little support for increasing the emphasis on proof or formal axiomatic structures, either. For the latter, a higher percentage favored decreasing emphasis (31.7%) rather than increasing emphasis (14.4%). On the other hand, the goal of learning to read and interpret mathematical arguments was strongly supported. Emphasizing reasoning techniques for ratio, fractions, decimals, and secondary geometry received moderately strong support (61% to 82%); however, emphasizing logical reasoning principles in elementary school geometry was not supported (44.6% opposed).

The modern mathematics movement emphasized the inherent structures of mathematics, but increasing the emphasis during the 1980's on curricula based on the logic of mathematics in order to understand the structure of mathematics was strongly supported for whole numbers (82.4%) and moderately supported as a generic (general) item (44.6% opposed).

The study of structural properties of number systems received higher support at the elementary level (68.5%) than at the secondary level (52.8%). When the study of properties of classes of numbers (e.g., integers, rationals, reals) was specified, support dropped even lower (49%). The tendency of respondents to rate general statements higher than specific examples was a pattern that is noticable throughout the PRISM survey.

Teaching Methods

Increasing the emphasis on individualization during the 1980's was given moderately strong support by the Arithmetic Teacher, supervisor, and teacher educator samples and by all the lay samples (principals, school board members, and PTA presidents). However, support for individualization was decidedly weaker among The Mathematics Teacher, junior college teacher, and college mathematics teacher samples. All groups gave moderately strong to strong support for providing classroom teachers with manipulative materials for classroom use in the areas of fractions, whole numbers, geometry, probability and statistics, ratio and proportion, and measurement.

Many respondents saw individualization as only one of several teaching techniques that should be used in the classroom. They were rather evenly divided as to whether more than 50% of the instructional time should be devoted to student use of individual study materials to develop and extend ideas. Instructional materials with specific objectives, criterion-referenced testing, and other aspects of a mastery learning or individually-paced model were given moderately strong support (above 63%) by all except the college mathematics teacher sample (which gave very little support). As might be expected, specifying competency levels in instructional materials received very strong support by lay samples (above 92%).

Respondents were asked about dividing classes into small groups for group work. Having students work in small groups to solve problems was given a higher degree of support (70% to 80%) than dividing the class into small discussion groups (36% to 58%). Most samples gave moderately strong support for having students develop ideas through long-term or real life projects for the areas of ratio, proportion, and percent; geometry; and probability and statistics. But project work for fractions and decimals and for algebra was not supported. Films, videotapes, and large-scale demonstration devices received strong to moderately strong support from all samples (ranging from 71% to 86%). The use of audiotapes for drill and practice was supported at the 75% level; however, audiotapes of lectures were negatively perceived by all samples. Providing students with measuring devices as resources for fractions and decimals, geometry, and measurement was given moderately strong support (73% to 80.5%), but when electronic measuring devices with calculator-like readout were suggested, support dropped to 45%.

When asked how much emphasis should be given to mathematics laboratories in the 1980's, only 48.2% indicated that they should be given increased emphasis, while 34.2% opted for the same level of emphasis, and 16.5% would give them "somewhat less emphasis." Lay samples gave stronger support (above 93%) to the use of physical materials and models than did professional samples; however, the use of materials for modeling problem-solving situations was supported by 83% of the professional samples. There was strong support for the use of manipulative materials in whole number mathematics from all samples except the college mathematics teacher sample (which gave only minimal support). There also was strong support (above 87%) for introducing basic ideas through laboratory investigations or experiments with materials at both the elementary and secondary school levels.

Survey participants were asked to imagine that an additional fifteen minutes per day could be spent on mathematics in elementary schools: how would they use this time? Respondents gave the highest priority to solving word problems, and the next highest priority to studying applications of mathematics. Nearly 80% indicated that students should be taught to find problems within situations; however, support for minimal (58.7%) for offering an interdisciplinary problem solving course.

Almost 66% of the respondents agreed that more than 50% of the instructional time for basic facts should be devoted to drill and practice. Lay samples gave moderately strong support (71.4%) to drill and practice in general, but the mathematics supervisor and teacher educator samples tended to disagree with the allotment of so much time to drill and practice. There was a generally stronger support (above 80%) for providing practice worksheets at the conclusion of every mathematics lesson, no matter what content was involved. The Arithmetic Teacher, The Mathematics Teacher, junior college, and college mathematics teacher samples gave strong support (81.9%) to providing whole number drill and practice in standardized test formats so that students would be prepared for later testing. However, mathematics supervisor and teacher educator samples gave only minimal support to standardized test formats for practice worksheets.

Well over 80% of the lay sample and approximately 70% of the professional samples indicated that basic skills should be given increased emphasis in the 1980's. When asked how they would spend an additional 15 minutes per day in elementary school mathematics, The Mathematics Teacher sample and the lay samples gave first priority to drill on
basic number skills. Other samples ranked problem solving and applications above basic skills as a focus for extra-time work. While basic skills received strong support for additional emphasis in the 1980's, the areas of problem solving, mathematical applications, and mathematics for gifted students received even stronger support.

Resources
Participants were asked about new or additional teaching resources that might be useful in several content areas. In every area where they were suggested—whole numbers; fractions and decimals; ratio, proportion, and percent; measurement; probability and statistics; algebra; geometry, and problem solving—resource booklets containing applications were strongly supported by over 80% of the respondents. In fact, resource booklets of applications were the most desired teaching resource in every area except fractions and decimals. On the other hand, collections of problems and applications meant to appeal to special groups, such as women or ethnic minorities, were only weakly supported. There was consistently strong support (above 80%) for using applications as a context for developing mathematical ideas and other instruction. Using applications as teaching methodology received even stronger support from the lay samples than from the professional samples. The key to this support seemed to be realism. Approximately 72% of the lay samples agreed that problems should be realistic even though they might involve sensitive social issues.

Instructional materials that included activities which required students to go outside the classroom were given moderately strong support by the supervisor, teacher educator, and lay samples. Probability and statistics, measurement, and computer technology were perceived as more suitable for out-of-class activities than were whole numbers; geometry; ratio, proportion, and percent; or problem solving.

The availability of special materials with minimal reading requirements was given moderately strong support by the Arithmetic Teacher, supervisor, teacher educator, and principal samples. However, The Mathematics Teacher sample gave weaker support, and the junior college and college mathematics teacher samples gave more support to these ideas. The school board member and PTA president samples also opposed the idea that reading should be deemphasized in textbooks and other materials. And “learning to read mathematics” received moderately strong support as a basic goal for whole numbers, algebra, and problem-solving (70.4% to 77.7%). Apparently reading was viewed as an important component of problem-solving: 54.1% disagreed with the oral presentation of problems or with the use of pictures and charts as a means to deemphasize reading.

Providing teachers with a syllabus that suggests topics and methods for each grade level with specific times these should be introduced received moderately strong support (70.9%) at the elementary level from the supervisor and teacher educator samples. However, support for secondary level was minimal (56.6%). The need for detailed notes to guide the teacher in oral presentations of lessons was seen as greater for computer literacy and for probability and statistics (over 62%) than in other content areas, where the level of support was 50% to 60%.

Classroom Technology
Nearly 75% of the professionals sampled and 80% of the lay people sampled believed that the use of computers and other technology in mathematics classrooms should be increased during the 1980’s. Respondents also gave very strong support to having computers or computer access for students at the secondary school level; support was slightly stronger for having several minicomputers than for having terminals connected to large computer. Although there was moderately strong support for having computers available at the elementary school level, almost no one believed that programming should be introduced in the elementary school. However, there was minimal support (57.7%) for having students interact with a computer or computer terminal as early as the primary grades. For the 1980’s, at least, computers seem to be clearly placed within the domain of mathematics departments. Eighty-one percent of the respondents opposed teaching computer literacy courses primarily within the social studies curriculum, and fifty-two percent opposed the establishment of separate computer science departments in high schools.

The availability of calculators in the mathematics curriculum depended primarily upon the audience surveyed. Strongest support for calculators came from the mathematics supervisor and teacher educator samples. From 73.7% to 85.3% of them believed that calculator usage in the classroom should be increased. They strongly supported (above 80%) the use of calculators to develop ideas and concepts, check answers, solve word problems, do homework, and compute areas, and make graphs. The supervisor sample strongly supported the use of calculators to learn why an algorithm works, although the teacher educator sample gave only moderate support to this idea. Even the use of calculators when taking a test was supported by these groups (74.8% and 83.1%).

The Arithmetic Teacher and The Mathematics Teacher samples and the junior college and college mathematics teacher samples had more reservations about using calculators. They gave very little support (44.7% to 51.3%) to increased emphasis on the use of calculators (although 20% or less in each sample would decrease calculator use). They gave moderately strong support (66.5%) for using calculators to develop ideas about decimals, but not about fractions or algebra. However, using calculators at the elementary level to explore values of algebraic expressions or limits of sequences was supported at the 70% level or above. Moderately strong support was given to the use of calculators to solve word problems in the areas of whole numbers and ratio, proportion, and percent, but very little support was given to using calculators to solve word problems in algebra. Minimal support (54%) was given to using calculators to solve algebraic equations; for geometric formulas, the approval rose to 68% to 84.3%. The reaction to using calculators when doing homework also depends upon the content involved. There was much stronger support for using calculators to do homework in probability and statistics (84.5%) and in ratio, proportion, and percent (70.9%) than for homework with fractions (36.5%) or geometry (54.7%). Interestingly, using calculators to do homework with decimals, whole numbers, and measurement all received moderate support (60% to 66%). Moderately strong support was also given to using calculators to do mixed calculations and compute areas. As might be expected, the level of support rose as the complexity of these problems rose. Strongest support of all came from using calculators to check answers. The pattern of support for using graphs was mixed. The Arithmetic Teacher and The Mathematics Teacher samples gave less support to graphing (48.7% to 62.2%) than did junior college and college mathematics teacher samples (70% to 76%). Finally, using a calculator when taking a test was generally opposed for the elementary level, although there was moderately strong support (54%) was given to using calculators to solve problems in the areas of whole numbers, fractions, and decimals; ratio, proportion, and percent; or problem solving.

The lay samples, especially the PTA president sample, tended to react at the other end of the spectrum. Forty-two percent of the PT sample felt that the use of calculators in the mathematics curriculum should be decreased. Strong support was given to answers with calculators, but over 70% of the PT sample opposed the use of calculators when doing homework or taking tests. Forty-six percent of the PT sample opposed the use of calculators for solving word problems, and opinion was divided on their use for developing ideas and concepts.

There was general agreement by all samples that basic facts should be learned first, before calculators are used. There was a strong belief that calculator use should be postponed until after paper-and-pencil algorithms are
learnt. Wide-spread support existed for the use of calculators in trigonometry. Beyond these areas, however, little consensus existed. Successful integration of calculator uses throughout the mathematics curriculum will require careful and thorough communication among all constituent groups.

Courses and Programs
Survey participants were asked to choose one new or extensively revised course to be added to the high school curriculum from a set of five choices. "A course that helps students make decisions about buying and selling" was the first choice of respondents. Third choice (after computer and calculators) was "a course that helps students understand the mathematics used in specific vocations and careers." When asked about the relative emphasis that should be given to different orientations of mathematics (without specifying an entire course), career or vocational orientation was top-ranked, with consumer orientation given second-choice. (Other choices were computer orientation, college-preparatory orientation, and recreational orientation.) Increased emphasis for gifted students was supported by over 75% of most samples. This response was exceeded only by the responses for increased emphasis given to problem solving and applications of mathematics. If more mathematics were offered to talented or gifted students, all samples would choose "a broad selection of topics" (60.0%), and would next choose computer and calculators. When asked about the relation of mathematics learning to problems involving characteristics or behaviors of students were of more concern than problems involving characteristics of schools, programs, or materials. Lowering of academic standards and lack of commitment to homework were of greater concern to The Mathematics Teacher sample than to other samples. The combined school board and PTA president samples tended to be more concerned about governmental restrictions and less concerned about teacher workloads than were other samples.

The highest priority as a method for attacking problems in mathematics was given to the inservice and preservice education of teachers. Evaluation of mathematics learning and achievement, allocation of grant money to local schools to improve their mathematics programs, and support of long-term research projects were ranked third, fourth, and fifth, respectively. First priority on distribution of research funds was given to studies of how students learn, with second priority given to research on teaching methods and third priority to research on teacher education.

In general, funding for local, small-scale projects was generally given priority over large-scale national projects. Least support was given to national curriculum projects and grants to commercial firms. While PRISM respondents showed a very practical orientation to mathematics, it should be noted that this was not their exclusive pattern of response. They also strongly supported such goals as "to learn to read mathematics, to develop logical thinking abilities, and to understand the structure of mathematics." But overall, they saw a great need for developing practical applications of mathematics during the decade of the 1980's.

Annotated references dealing with the use of calculators in education are presented, with each entry including a limited set of descriptors to denote the focus of the reference. An index is included.

Mathematics Education

Calculators: A Categorized Compilation of References
Marilyn N. Suydam ED 171 572

Recent ERIC/SMEAC Publications

Readers wishing to order a copy of any of these publications may either purchase them from the ERIC Clearinghouse for Science, Mathematics and Environmental Education or may order from the ERIC Document Reproduction Service (EDRS), P.O. Box 190, Arlington, VA 22210. Materials ordered from EDRS may be purchased as microfiche or papercopy. Prices and ordering information are found in the document resumes. in Resources in Education (RIE) as are order forms. Any Clearinghouse documents with SE numbers have been sent to EDRS for publication in a future issue of Resources in Education and will have an ED number when each appears in print.
Variables describing problem tasks are categorized and defined to provide a framework for research in problem solving. A model for the classification of task variables into broad categories is presented. The existing research literature is surveyed and the theoretical implications of task variables within a category are explored.

Variables describing problem tasks are categorized and defined to provide a framework for research in problem solving. A model for the classification of task variables into broad categories is presented. Other articles relate to the definition and discussion of each category of task variables, with examples. The existing research literature is surveyed and the theoretical implications of task variables within a category are explored.

Applied Mathematical Problem Solving
Richard Lesh, Diane Mierkiewicz, and Mary Kantowski, editors

Nine papers are presented, relating to varied perspectives on applied problem solving.

Understanding the Realities of Problem Solving in Elementary School With Practical Pointers for Teachers
Linda Brandau and Jack Easley

Part I of this document is focused on an attempt to connect the reality of the classroom with the idealism arising from some of the problem solving literature. Part II contains an examination of what "problem solving" might mean in the context of an elementary school classroom. A consideration of how children may be helped to understand the non-arbitrary character of rules of arithmetic by examining the connectedness of mathematical ideas, rules and procedures is found in Part III. A list of references and recommended readings, a list of specific pointers for teachers, and a conclusions section are also included.

An Analysis of Mathematics Education in the Union of Soviet Socialist Republics
R. B. Davis, T. A. Romberg, S. Rachlin, and M. G. Kantowski

The current status of mathematics education in the Union of Soviet Socialist Republics is reported. Discussed are common practices in present Soviet schools, difficulties in language, Soviet mathematics curriculum, and mathematics education research and development in the Soviet Union. Soviet approaches to the study of problem solving processes in mathematics are considered.

Assessing Mathematical Achievement
Jon L. Higgins, Margaret Kasten, and Marilyn N. Suydam, compilers

Designed to serve as a reference on assessments of achievement in pre-college mathematics, this report contains a discussion of mathematical assessments in terms of the history and nature of assessments of achievement, the relationship between assessment and minimum competency testing, and the current status of state assessment programs. Portions of reports of the National Assessment of Educational Progress and the California Assessment, grades 6 and 12, are presented in order to examine trends in mathematics achievement.

Some Theoretical Issues in Mathematics Education: Papers from a Research Presession
Richard Lesh and Walter Secada, editors

Three addresses by internationally renowned mathematics researchers and a fourth paper on the role of research are presented. Each of the addresses (by Heinrich Bauersfeld, Efraim Fischbein, Hans Freudenthal) focuses on the learning process but from different points of view.

Research Reporting Sections, Annual Meeting of the National Council of Teachers of Mathematics (58th, Seattle, WA, April 16-19, 1980)
Jon L. Higgins, editor

Abstracts of 14 research reports relate to such topics as the effects of games on mathematics skills and concepts, sex differences in mathematics achievement and participation, locus of control and mathematics instruction, and the psychology of problem solving.

A Categorized Listing on Research on Mathematics Education, 1974-1978
Marilyn N. Suydam

Articles, dissertations, and ERIC documents for the five-year period are included. An index contains research reports grouped by categories for major topics.
Materials on Energy-Related Careers

Editor's Comments

This issue of the ERIC/SMEAC information bulletin contains descriptions of materials on energy-related careers. Materials described were announced in either Resources in Education (RIE) or Current Index to Journals in Education (CIJE).

Persons interested in obtaining copies of any of these materials should check a recent issue of RIE for an order form and for any changes in the price of paper copy or microfiche copies of the documents. Most of the articles announced in CIJE are available from University Microfilms International. Ordering information for copies of such articles is given at the beginning of the section of the bulletin in which the articles are described.

This issue of the bulletin was prepared by Bernard J. Lukco, Education Specialist, National Training and Operational Technology Center, Cincinnati, Ohio.

SECONDARY

The College of Education, Texas A and M University, has produced a 37-page publication that serves as an introduction for high school students to energy-related careers. Information on careers in manufacturing, business and industry, and electrical energy production is featured. The purpose of the document is to guide interested students into productive careers that will help solve serious national problems related to energy. Twenty-one careers are described. An overview of each occupation, future opportunities, general requirements, and estimated salaries are included for student use.

Copies of Energy Related Careers (ED 167 414) can be obtained for $3.32 for paper copy, $0.38 for microfiche, from:

ERIC Document Reproduction Service
P.O. Box 190
Arlington, VA 22210

POST SECONDARY

A data report describing the procedures and findings of a summer 1978 peer-to-peer telephone information exchange between the Education Programs Division of the U.S. Department of Energy, and various vocational-technical schools throughout the United States represents a preliminary investigation of a comprehensive study to assess the state of the art of energy education activities within two-year post-secondary educational institutions. The energy areas investigated were coal technology, petroleum technology, nuclear technology, solar energy, energy conservation, and energy generation and transmission.

The peer-to-peer telephone information exchange was designed to meet five major objectives:

1. To determine number and types of energy-related occupational-technical programs currently being offered by a representative sample of post-secondary vocational-technical institutions.
2. To determine number and type of energy-related occupational-technical programs being planned by a representative sample of post-secondary vocational-technical institutions.
3. To assess public interest in energy-related occupational-technical areas by ascertaining which energy-related short courses have been offered in the past two years in a sample of post-secondary vocational-technical institutions.
4. To determine the expressed need and current funding for energy-related occupational-technical programs within the public and private sectors of a representative sample of post-secondary vocational-technical institutions.
5. To assess the need for dissemination about energy-related occupational-technical programs among vocational-technical institution staffs and to create an awareness of the role of the Education Programs Division, Department of Energy, as a facilitator and catalyst in establishing a national energy education communications network among community colleges and vocational schools.

The report, "Energy-Related Activities in Two-Year Postsecondary Vocational-Technical Institutions, A Representative Sampling by State (DOE/ER-0080), is available to a limited number of requests from:

U.S. Department of Energy
MS7E-054
Education Division
Washington, DC 20585

SOLAR

Solar energy is typical of the emerging energy fields that will have career implications. Projections regarding workforce needs are not readily available for many of the occupations that will evolve during this decade. To assist with occupational planning, the U.S. Department of Energy, Office of Education, Business and Labor Affairs, and Office of Solar Applications, conducted a study, Solar Energy Employment Requirements 1975-1985. The study describes characteristics of establishments engaged in solar energy work and the number and occupational distribution of persons working in solar energy activities in 1978.

The scope of the study includes all types of solar energy technologies and applications (space heating and cooling, water heating, industrial process heat, thermal power, ocean thermal conversion, photovoltaic conversion, wind conversion and biomass conversion), and all phases of work (research and development, manufacturing, marketing and distribution, and installation and maintenance).

It is estimated that approximately 2,000 establishments, both public and private were engaged in solar energy activities in 1978. Approximately three out of every four of these establishments were primarily working in solar-space and water heating. The states with the most solar establishments were California (16 percent of the total), New York (8 percent), Massachusetts (7 percent), Colorado (4 percent), and Texas (4 percent).

Approximately 31 percent of the establishments were involved in the manufacture of solar collectors or other solar products. About 23 percent provided research and development services, and 18 percent provided architectural and engineering services. Twelve percent
were engaged in installation and 16 percent provided other solar-related services.

The total estimated number of persons working in solar energy in 1978 was 22,500. This figure represents all employees, both full and part-time. Unskilled workers made up the largest occupational group in commercial activities, and skilled workers made up the largest occupational group in installation. Engineers comprised the largest occupational group overall. Employers were asked to estimate the number of additional solar jobs which their establishment would add by 1981. The anticipated gain in solar employment was estimated to be 90 percent with the largest gains anticipated for skilled workers and technicians in the fields of manufacturing and construction. Only one out of every four employers thought their professional, technical or skilled craft employees performed tasks that were substantially different from those traditionally performed in nonsolar jobs. Where new skills were identified, special solar design, analysis and installation skills were most frequently mentioned by employers. Thus, there appears to be some need for persons trained in the design and analysis of new solar systems, and for persons trained in installing these systems. However, these employees must be capable of performing traditional as well as purely solar work.

Copies of the report, DOE/TIC-11154, are available from:

National Technical Information Service (NTIS)
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

Price: Printed Copy $9.25; Microfiche $4.00.

ASSESSMENT

National Environmental/Energy Workforce Assessment

The Post-Secondary Education Profile, Phase II of the National Environmental/Energy Workforce Assessment, consists of 16 volumes which cover the following topics: air, energy, noise, pesticides, potable water, radiation, solid waste, wastewater, composite, and the private sector. The sample study was designed to provide an overview of environmentally related postsecondary education programs, their structure, representative course offerings, employment history of graduates, and the faculty organization.

The energy programs described in the sample are extremely diverse. Enrollments vary from fewer than 10 to more than 600 students. Nearly 60 percent of the students are in bachelors programs, about 25% are enrolled in associate degree programs, 13% in masters programs, and about 3% are in doctoral programs. Fewer than 5% of the students enrolled in energy programs are women.

Well-established programs in nuclear engineering, and mining petroleum and natural gas technology and engineering are defined. Additionally, there are unusual offerings in energy conversion, energy resources management, and others which represent recent innovative approaches to a broad spectrum of energy problems. Seven of the associated degree efforts either require or contain an active option of internships; 13 of the bachelor programs do so, as do nine of the masters programs. Several respondents singled out the applied study aspect as the most important component distinguishing their program from similar efforts.

The information included in the energy volume is evidence that people are doing more than just talking about our future. In addition of established curricula there are innovative efforts such as Cornell's College Program in Energy Conversion, the departmental Energy Engineering and Policy program at the Polytechnic Institute of New York, the Energy Conversion and Resources Topical Program at Princeton, the undergraduate Energy Resources Management program of Lamar University, the graduate University of Pennsylvania Energy Management and Policy multidisciplinary program, and several others which represent recent innovative approaches.

The Associate level curricula included in this energy volume are of three basic types: Mining Technology, Petroleum Technology, and Nuclear Engineering/Safety Technology. Graduates are prepared for the following occupations:

Entry Level Miner (Coal)
Petroleum Engineer Technician
Industrial Radiologist
Radio-Chemistry Technician
Health Physics Technician
Property Analysis Technician (Petroleum)
Reactor Operator
Research Assistant
Air Pollution Control Technician
Environmental Tester/Analysts
Drilling Technician
Physical Science Technician

Bachelors-level curricula prepare students for the following occupations:

Chemical Engineer
Electrical Engineer
Energy Efficiency Technician
Energy Engineer
Geophysicist
Mechanical Engineer
Metallurgist
Mineralogist
Mineral Processing Engineer
Mining Engineer
Mining Geologist
Nuclear Engineer
Nuclear Technician
Petroleum Engineer
Petroleum Geologist
Physicist
Power Reactor Operator
Agronomist
Bacteriologist
Biochemist
Biophysicist
Chemist
Ecologist
Environmental Control Technologies
Nuclear Plant Operator
Strip Mine Inspector
Solar Energy Technician
Resource Conversion Technician
Industrial Engineer
Safety Engineer
Petroleum Geologist Technician

Graduate level curricula prepare people for the above occupations and, in addition, the following:

Environmental Physicist
Mechanical Engineer (Conversion)
Energy Policy Analyst
Environmental Monitor Specialist
Environmental Science Technician
NRC License and Standards
Electric Power Engineer
Energy Management Systems Analyst
Industrial Hygienist
Oceanographer
NRC Inspector

Most respondents felt that energy education will continue to grow and to proliferate at post-secondary institutions. Many observed that courses are becoming increasingly technical in emphasis and this trend will continue. Some viewed energy management and analysis as among the most crucially needed areas in the near future and, thus, most promising for employment opportunities. Others noted that programs with teaching and research commitment to alternative energy sources and technology are only now emerging.

Graduates of energy programs generally have highly sought after skills and have little difficulty finding employment. This condition is expected to continue and improve even as enrollments and subsequent graduates increase, simply because energy related expertise is in great demand.

The U.S. Environmental Protection Agency funded all three phases of the workforce assessment study.

National Environmental/Energy Workforce Assessment, Phase II, Post-Secondary Education Profile: Energy (ED 161 735) can be obtained from:

ERIC Document Reproduction Service (EDRS)
P.O. Box 190
Arlington, VA 22210

Microfiche, $0.83; paper copy, $21.32. Phase I of this study focused on the development of workforce demand projections through 1992 for all public environmental agencies culminating in a
numerical profile of growth patterns and workforce needs at national and state levels.

Phase III contains program entries from junior colleges, vocational/technical training institutes, community colleges, four year colleges, and universities, as well as other training institutions. In total, 1,359 programs representing all 50 states, the District of Columbia, Puerto Rico and the Virgin Islands are represented.

The twelve-volume Phase III report is available for $55 from:

Graphic Printing
National Copy Center
P.O. Box 986
Iowa City, IA 52240

PATTERNS

The changing patterns of energy use expected to occur over the next several decades will also create a change in the national workforce. New technologies will require skills and knowledge not presently offered in traditional educational institutions. Careers will evolve from an emphasis on alternative energy sources. Modifications to the labor force will be needed in established energy fields as more efficient and environmentally compatible operations are established. Occupations that were not previously related to the energy field will take major responsibilities. The U.S. Department of Energy’s Energy offers two publications that can be of assistance to anyone concerned with selecting an energy occupation. Professional Energy Careers presents information on 20 various occupations related to the broad range of energy matters. A brief description of the field, suggestions for formal training, and additional sources of information are offered for each occupation. Careers in Energy Industries projects the demand for jobs in the exploration and extraction of coal, uranium, natural gas, and petroleum; petroleum refining; oil shale processing; production of synthetic fuels from coal; and the construction, operation, and maintenance of central station power plants. Although estimates of future requirements for expanded energy facilities must be viewed as tentative because of the diversity and complexity of the field, the employment trends, as listed in the pamphlet, can be useful for career planning purposes.

Copies of either publication can be obtained free of charge from:

Energy
P.O. Box 62
Oak Ridge, TN 37830

Those wishing to borrow negatives to print large quantities of these or other publications, should contact:

U.S. Department of Energy
Editorial Services (GA-343)
Office of Public Affairs
Washington, DC 20585

EEAC

Meeting Energy Workforce Needs was the theme of a conference sponsored by the U.S. Office of Education’s Energy and Education Action Center in February, 1980. Nationally recognized authorities were invited to present papers in their respective fields. Presentations addressed topics such as the best available assessments of future job opportunities in energy-related occupations, curricula available, capabilities of schools, colleges and other training facilities to meet anticipated demands, effective guidance and counseling programs, and efforts to improve linkages between education, industry, government and labor.

William L. Smith, U.S. Commissioner of Education opened the conference with remarks about “Education's Role in Meeting Energy Workforce Needs.” The following lists the agenda at the session:

Energy Development—Is There a Need for more People?—Norman Setzer
The Future Workforce Requirements in Energy Producing Industries—Neal H. Rosenthal
Solar Energy Employment—Girard W. Levy
Training for Solar Jobs: A Follow-up of California CETAs Programs and Their Graduates—Barbara A. Burns, Bert Mason and Gail V. Mikasa
Occupational and Training Requirements for Expanded Coal Production—John B. Ostbo
Update of Employment Trends in Nuclear Power Industries—Larry M. Blair
Forecasting Construction Labor Requirements for Powerplants—William F. Hahn
Strengths and Pitfalls in Doing a Needs Assessment in Emerging Energy Technologies—Marcus C. King
Training Programs and Advanced Education in Solar Energy—Kevin O’Connor
Workforce Training Implications of an Empirical Survey of Energy Curricula—Ethel Simon-McWilliams
Counseling for Career Opportunities in Energy-Related Industries—Mayme R. Crowell
The Development and Dissemination of Career Information for Student/Workers—Russell B. Flanders
Orienting America's Youth Towards Future Energy Careers—Ann L. Borden
Career Education and the Energy Crisis—Kenneth B. Hoyt
Opportunities for Women in Energy—Mary Lou Randour
Linkage Efforts Among the States—Edith M. Petrock

Industry and Linkage Building—George H. Lawrence
Improving Linkages Among Governmental Organizational Entities—Wilton Anderson
A Model Needs Assessment—Michael J. Nastick
Renewable Energy and Employment: Decentralized Energy and Jobs in the 80's—Scott Sklar
A Profile of Energy Education Programs—Jack Seum
Employment, Education, and Recent Legislation—Wayne Stevenson
Vocational and Adult Education-Energy and the 80's—Daniel Dunham
Broad-Based Curriculum for Training Energy Conservation and Use Technicians—Michael E. Blackmon
Project EFFECT: Energy for the Future: Education, Conservation, Training—Gail S. Dowdy
Energy Education and Elementary and Secondary Schools—Shirley J. Hansen
Energy and Jobs for the Future—Rafael Fermoselle
Training Technicians for Coal-Fired Power Plants—Bonnie F. Rinard
Training Programs of a Public Utility—Sondra J. Gillice
Energy, Education and Economic Development—Ann M. Martin
Energy Impacts on Our Health Delivery System—Gordon W. Berg

Copies of the proceedings, cloth bound, 336 pages, titled, Meeting Energy Workforce Needs, Determining Education and Training Requirements can be obtained from:

Information Dynamics, Inc.
111 Claybrook Drive
Silver Spring, MD 20902

The cost is $20.00 if remuneration accompanies the order. Otherwise, add $1.50 for handling.

GWAZDA

Energy Occupations Handbook, by Edward GwaZda and others, is a student handbook which includes surveys of energy fields and occupations, career guidance activities for energy-career decision making and choice, and resources for energy career education, including state and national educational programs, selected student and professional readings, audio-visual and curriculum materials and a directory of related businesses and industries. Over 60 different fields and 60 different occupations are described in some detail. Career guidance sections provide practical advice for selecting, preparing for, and obtaining employment in energy-related fields.

The publication was prepared by the Center for Coastal and Environmental Studies; Rutgers University; for the New
collections located at major library centers throughout the nation. Copies of Resources in Education (RIE) update documents abstracted by ERIC Clearinghouses on a monthly basis. Resources in Education may be ordered from:

Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402

Resources in Education ... Yearly subscription
Monthly Abstract Journal
Domestic $42.70
Foreign $53.00

ED 127 431
Federal Agencies for Career Education Services.
Office of Education (OHEW), Washington, D.C. Pub Date Jan 76
Note—48p.
EDRS Price MF-$0.83 PC-$3.32 Plus Postage.
This guide to federal government resources contains two major parts: (1) a set of descriptions of 38 federal programs that offer various types of resources for career education, and (2) a set of indices to help the practitioner use these programs. Indices include the following categories for each program: Program title, description, relationship to career education, and financial assistance, publications, and where to get help. Stated limitations to the guide are that it does not promise to include all federal government programs that may be of interest to educators in career education, and it does not present detailed information on how to obtain funding from the programs described. It is suggested that the practitioner contact the programs directly for this information. (TA)

ED 142 792
Brookings, Walter J.
Energy Related Technology Programs at the Non-Baccalaureate Postsecondary Level.
Pub Date 6 Jul 77
Note—27p.; Speech presented at a National Invitations Conference. Conference was sponsored by the Energy Research and Development Administration's Division of Labor Relations and the American Association of Community and Junior Colleges, Atlanta, Georgia (Oct 67, 1976.)
EDRS Price MF-$0.83 PC-$3.32 Plus Postage.
Identifiers—Coal, Geothermal Energy, Nuclear Energy
Guidelines are presented for institution administrators considering the initiation of programs to train energy-related technicians at the associate degree level. Two essential preliminary steps are outlined: (1) Acquiring and analyzing all available information about the proposed field including national legislation and the probable need for technicians in the area served by the institution. Study questions for the decision to develop a curriculum are followed by the caution that introducing and refining a new program takes a minimum of five years and also involves determining the need for additional facilities and the availability of qualified instructors. Potential areas for program development are then discussed individually for each related technician in coal mining, beneficiation, and processing; petroleum extraction and refining; nuclear power production; solar energy; conversion of wind, geothermal or tidal energy; and possibly a new type of technician, the energy monitoring of control technician. A list of names and addresses of junior colleges with existing and planned energy-related technology programs is attached for each of four program areas: Coal, petroleum, nuclear, and solar. (BL)

ED 142 794
Moore, Allen B.
Energy Problems Provide Job Opportunities.
Ohio State Univ., Columbus. Center for Vocational Education
Spons Agency—Bureau of Occupational and Adult Education (DHEW), Washington, D.C.
Pub Date 1 Jul 77
Note—15p.
EDRS Price MF-$0.83 PC-$1.82 Plus Postage.
In response to the problems created by a diminishing energy supply but an increasing energy demand, this second in a series of national reports studies the linkage of vocational education and energy. Through an examination of selected literature with reference to types of energy resources, the author identifies the emerging occupations related to the development of alternative energy sources and considers the relevance of these occupations to vocational education. (SM)

ED 186 028
Grossman, Richard Daneker, Gail
Guide to Jobs and Energy.
Pub Date—Jan 78
Note—25p.; Not available in hard copy due to copyright restrictions
Available from—Environists for Full Employment, 1101 Vermont Avenue, N.W., Room 305, Washington, D.C. 20005 ($3.00)
EDRS Price MF-$0.83 PC-$3.32 Plus Postage. PC Not Available from EDRS.
This document is a review of the work being done in the area of energy and the economy. The authors believe that increased energy efficiency, plus more jobs than the large scale system scenario, which corporate energy interests, many industrialists, and some government agencies, are promoting. The document includes the following sections: (1) energy and the economy, (2) substitution of energy for labor; (3) productivity and jobs; (4) energy growth and prosperity—the myth; (5) energy inefficiencies; (6) capital investment; (7) energy efficiency and jobs; (8) solar, wind, and biomass conversions; and (9) the politics of solar energy. Extensive footnotes are given. (TM)

ED 187 786
Bartley, Hugh J. And Others
Career Fields for Inspection and Enforcement Personnel
Report No.—NUREG-CCR-0042
Pub Date—Oct 78
Contract—NRC-05-77-174
Note—135p.; Not available in hard copy due to reproducibility problems
Available from—National Technical Information Service, Springfield, Virginia 22161 ($6.50, printed copy; $3.00, microfiche)
Pub Type—Reports-Descriptive (141)
EDRS Price MF-$0.83 PC-$3.32 Plus Postage. PC Not Available from EDRS.
This document is the General Research Corporation (GRC) report on Task II, which called for the development of career fields for headquarters personnel, regional positions of the U.S. Nuclear Regulatory Commission Office of Inspection and Enforcement (NRC/IE). GRC examined the data from Task I (development of qualifications requirements) for cross-mality of knowledge and performance, postulated career fields as a result of that examination, and tested and revised those career fields by more extensive examination. Proposed as a result of this are four career fields: construction-vendor, health physicists, reactor operators, and safeguards; and two "career ladders" for investigation. (The term "career ladder" was chosen to describe the relatively narrow patterns of openings to open members.) All career fields include subfields, which are described in full in the report. In addition to recommending acceptance of these career fields, this document proposes the combination of certain subfields, the rationalization of some positions, and the development of a career field nomenclature for all NRC/IE positions. (Author)


This study guide groups eleven lessons into four study units. The first discusses the development and basic concepts of solar heating. The second unit deals with the components of the solar heating system. The third study unit covers sizing of the solar heating system to meet demand and discusses the operation of the total system. The fourth unit presents a summary concerning installation and servicing of solar assisted heating systems. There are review tests and unit examinations structured for assistance in reviewing the material and in integrating new information with that learned previously. (Author/RE)

ED 170 123 SE 027 540 Energy Conservation Workshop — Training Requirements for Technicians (Atlanta, Georgia, October 30-November 1, 1977). Department of Energy, Washington, D.C. Div. of Power Systems. Pub Date—Mar 78 Note—54p.; Contains occasional light type Available from National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161 ($5.25) Pub Type—Guides—Classroom—Learner (141) EDRS Price—MF $.83 PC-$11.77 Plus Postage Descriptors—Community Colleges, Energy, *Energy Conservation, *Fuel Consumption, *Higher Education, Postsecondary Education, Socioeconomic Influences, *Technical Education, Technological Advancement, *Technology Transfer, *Vocational Education, Workshops. This workshop was designed to study the training requirements of skilled technicians who will be required to install, operate, and maintain the advanced energy systems developed by the Division of Power Systems of the Department of Energy (DOE). Community college educators and DOE technology program administrators were brought together to develop recommendations concerning the status of current programs, future needs, and ways needs could be solved. Included in this document are sections containing conclusions and recommendations of the conference, background of the conference, and a conference report. Appendices include a list of workshop participants, a description of the DOE's Division of Power Systems, an overview of the characteristics of the junior college and community college system. (RH)


This resource guide was prepared to assist educators in incorporating energy concerns within the school curriculum. It is intended to provide a basic framework of objectives for different subject areas and to provide examples of activities for teaching towards the stated objectives. Resources are listed to aid the teacher in developing additional activities. The resource guide is based on the assumption that its contents will provide a strong point and that teachers will go further in devising lessons in energy instruction. (Author)

UMI

Most of the articles that follow are available from University Microfilms International. Those articles are indicated by the presence of (UMI) following the journal citation. The price is $4.00 for each article dated after January 1980 and $5.00 for articles dated prior to that date. Articles are reproduced to approximately original size, to a maximum of 8½x11 inches. Be sure to include the EJ number, author, title, name of journal, volume, issue number and date for each article required. Order from:

Article Copy Service—CIJE UMI Article Reprint Department 300 North Zeeb Road Ann Arbor, MI 48106 (800) 521-0600

EL 148 003 VA 507 759 Coal Week: Answering a Community's Educational Need Zanelia, Richard C Phi Delta Kappan, v58 n4, pp335-337, Dec 76 *Occupational information, "Career Awareness," "Community Involvement," "Program Description." Senior High Schools A week-long special program introduced the students to the mining industry and involved members of the coal industry and of the community. (IRT)


EL 199 168 CE 508 265 Energy Vocational Instructions Fowler, John M.; Kryger, King VocEd; v54 n1, p41-43 Jan 79 (Reprint: UMI) Pub Type: Guides—Classroom—Teacher (052); Opinion Papers (120) Descriptors: "Conservation Education; *Conservation (Environment); Curriculum Development; Ecological Factors; *Economics Factors; Educational Needs; Employment Opportunities; Energy; "Energy Conservation; "Fused Curriculum; *Interdisciplinary Approach; Social Environment, *Vocational Education IDs: *Energy Education

From their experience in the National Science Teachers Association's Project for an Energy-Enriched Curriculum, the authors discuss short-range and long-range energy problems and the multifaceted requirements of curriculum instruction must make to tackle these problems. Energy/environment economics topics should be infused into the curriculum and vocational students prepared for environmental conservation careers. (MF)
Seven speeches given at the workshop were: The Natural Energy - Fiscal Response, Dr. John A. Bolding, Energy Conservation Education—Major Considerations, Professor Elias P. Gyftopoulos, False Images in Engineering Education, Donald E. Shadbolt; and Effective Methods of Delivering Appropriate Information—A Status Report, Dr. Harvey J. Bierman. Project PROCEED—Its Learning Design, Professor Karen C. Cohen; and Project PROCEED—How It Works, Dr. C. Michael Mohr. (ERA citation 04:00839)


Because of the energy resources located on Native American owned lands, it is pertinent that the tribes on these reservations receive information, training, and technical assistance concerning energy and the environment and the decisions that must be made about energy-resource development. In the past, attempts to enlist Indians in technical assistance programs met with little success because teaching methods seldom incorporated program planning by both tribal leaders and the technical training staff. Several techniques used to maximize reservations in the central and western parts of the country were conducted by Argonne National Laboratory program. Pet stressed practical, on-the-job experience through lecture, laboratory, and field studies. Each program was designed by ANL and tribal leaders to fit the needs and concerns of a particular tribe. The individual programs met with an impressive degree of success; they also prompted several Indians to pursue this type of education further at ANL and local Indian community colleges and to obtain funds for energy projects. Despite the positive feedback, several difficulties were encountered. Among them, a program must usually modify the programs to fit diverse tribal needs, to diminish politically motivated interference, and to increase portions of the funding to involve more Native Americans. (ERA citation 04:00039)


This handbook was prepared by the Technology Applications Group, L.L.C., for the "Solar Workshop for the Plumbing and HVAC Engineer," held at the Marina City Club, Marina del Rey, California on March 10 and 11, 1978. Discussed in order are solar components and systems (collectors, storage, service hot water systems, space heating with liquid and air systems, space cooling, heat pumps and controls);) computer programs for system optimization; local solar and weather data; a description of buildings and plants in Southern California applying solar technology; current Federal and California solar legislation; standards, codes and performance testing information; a listing of manufacturers, distributors, and services available for the Southern California region; and information access. Finally, the last section provides solar design check lists for those engineers who wish to design their own systems. (ERA citation 03:0522479)


Characteristics of professional energy-related scientists and engineers in 1976 and changes in this group from 1974 to 1976 are described. The data come from the 1976 Survey of Natural and Social Scientists conducted by the Bureau of the Census for the National Science Foundation. There were 114,935 experienced scientists and engineers indicating that their work was energy-related in 1976, more than in 1974, Unemployment, low at only 1.9 percent of all experienced scientists and engineers, was again low for energy-related scientists and even for energy-related engineers. Females make up 4.6 percent of all experienced scientists and engineers but only 0.8 percent of energy-related scientists and engineers in 1976. Experienced scientists and engineers whose work was not energy-related, the energy-related earned higher salaries, were more often employed by private business, more often managers and were rather heavily concentrated in the West South Central region. 1 figure, 11 tables. (ERA citation 03:046054)

Energy Education — Jung Center — Feasibility Study, Georgia H. Al. adv. Western Oregon Community Development Credit Union, Coos Bay, Oregon, June 78, 300p. Price code: PC-$15.00/$M-$5.50.

A study of the impact of rising energy prices J.0. 99 and near poor, especially in the state of Oregon and Washington. The creation of the energy education training center is proposed as an agent in bringing energy conservation measures and technological innovations such as solar power to the local level.

Do not hallucinate.
the case of a university contractor with
the responsible professor or principal
investigator.

I. Faculty Research Participation

Summer or academic year appointments
are available with a general limita-
tion of 12 months total under the
program. Most appointments are made
for the summer period; however, sabb-
atical year appointments are also con-
sidered on a partial support basis. The
program is principally one of research,
working with a laboratory staff member
on a problem of mutual interest. Applic-
ants must be full time faculty members
of an accredited college or university
with a commitment to continue teach-
and or research as a career.

II. Student Research Participation

This activity provides qualified
junior/senior level undergraduate sci-
ence and engineering students the op-
portunity to participate in research, de-
velopment and demonstration pro-
grams at approved DOE Laboratories of
Energy Technology centers. Most, though not all, appointments are for the
summer period.

III. Laboratory Graduate Research Par-
ticiple

Selected full-time graduate students
enrolled in accredited universities may
receive appointments of up to one year—renewable to a maximum of three
years—to carry out their Ph.D. or mas-
ter’s thesis research in residence at a
DOE Laboratory or Energy Technology
Center. The purpose of the program is
provide opportunities for graduate
students to carry out their dissertation
requirements when the necessary
facilities or resources are not available
on campus.

IV. Thesis Parts Research Participation

This activity provides opportunities
for full-time graduate students to con-
duct short-term portions of their research a few days to several weeks at
a DOE facility having a special resource
or equipment required for the research.

In addition to the research participa-
tion opportunities, there are several
supplemental, short term educational
and training activities designed to com-
plement and support training needs and
energy curriculum requirements. Fa-
culty institutes, workshops, confer-
ences, visiting lecturers, and faculty re-
search visits are periodically offered.
For information on specific require-
ments and the address of Laboratory
and Technology Centers, write:

U.S. Department of Energy
Office of Energy Research
University and Industry Programs
Division
Washington, DC 20585

Information on curricula needs and
specific energy programs implemented
community and junior colleges is av-
ailable from the Energy Communica-
tions Center, American Association of
Community and Junior Colleges
(AACJC), 1 Dupont Circle, Washing-
ton, DC 20056. The AACJC developed
the following energy-related materials and
activities.

Energy-Related Technology in Com-
munity and Junior Colleges, a study
published in July, 1976 for ERDA, writ-
ten by John R. Doggette of Oak Ridge
Associated Universities, Oak Ridge,
Tennessee in cooperation with AACJC.

AACJC Office of Governmental Rela-
tions conducted a survey in spring 1978
to assess variety and scope of energy
technician courses and curricula of-
fered nationally in community colleges.
The report is available at AACJC: A Sur-
vey of Energy Programs in Two-Year
Colleges and Technical Institutes.

An appropriate technology roundta-
ble was held at AACJC on July 19-20,
1979 with National Science Foundation
support to pursue questions: Is there a
role for community college in approp-
riate technology? Does the role include
instruction, information, and/or catalyst
for action? (Report available at AACJC:
Community College and Appropriate
Technology.)

In the summer 1979, the Energy
Promote project was funded by the Na-
donment for the Humanities
and the Department of Energy with ad-
ditional collaboration with Ted Turner's
Atlanta Super Station and others. Cur-
rently, more than 450 colleges are par-
ticipating. Coordinating colleges in
each of the 10 federal regions were
selected. The project purpose is to help
local citizens understand energy condi-
tions, the current and future impacts of
energy costs and shortages on their
lives, and the adjustments in life style
which may be required. The program of-
fers opportunities for citizens to ex-
press their ideas and concerns. Mate-
rials are available at AACJC.

In August 1979, the Department of
Energy funded the Energy Communica-
tions Center, a one-year program de-
digned to collect and disseminate in-
formation concerning community col-
gel energy programming including curriculunm, courses, continuing educa-
tion, construction, retrofitting (thermal
drapes, double-pane windows, insula-
tion, etc.), educational materials, and
other activities to encourage energy con-
servation. The project will produce
the following monographs:

A. Energy Curriculum Guide
B. Energy Conservation-Community
College Approaches

Both will be available at AACJC in
1980. The Center is also working with
the DOE, Office of Consumer Affairs on
the recently funded Alcohol Fuels Pro-
duction Workshops program. The suc-
cessful applicants in this competition
(30 of 40 are two-year postsecondary insti-
tutions) are identified in the January
1980 issue of The Energy Consumer.

The Center is supporting Colby Com-
nunity College, Colby, Kansas in pro-
ducing a training manual and video-
tapes on alcohol fuels production.

National Center for Resource De-
velopment (an AACJC affiliated council)
is producing a program that will pro-
duce a guide to community college
energy program funding sources, a
booklet of case studies, and recom-
mandations for future activities.

Scoreboard
A project that exemplifies the type of
energy education effort that can directly
influence homeowners is The Energy
Scorecard, developed by Energy Infor-
mation Associates for the Colorado
Energy Extension Service. About 50,000
score cards were distributed through-
out the state to enable individual
homeowners to audit their energy use in
three areas: transportation, the home
and appliances. Energy points are as-
sessed for how individuals used energy
over the past year. Energy saving points
are also awarded based on energy con-
servation steps taken within the past
two months. Each section has a sum-
mary at the end to total up scores and
compare them to the average Colorado
energy user. A Teacher's Guide was
subsequently developed to encourage
junior high school teachers to incorpo-
rante energy education in their clas-
srooms. Ten workshops with 40
teachers enrolled in each have been con-
ducted to assist implementation of the
program. Classroom activities for home
conomics, mathematics, science
and social studies are included in the
Guide. A limited number of copies are
available and can be obtained by con-
tacting:

Robert P. Brown, Director
Colorado Energy Extension Service
1600 Downing Street
Denver, Co 80218.

Managing
Managing Your Home's Energy Dol-
lar, An Energy Management Workbook
for the Homeowner, was distributed to
homeowners in several Colorado coun-
ties to encourage energy conservation.
The easy-to-read 37 page publication
covers such topics as reading utility
meters, monitoring energy use, sugges-
tions to make the home more energy ef-
cient, decisions about conservation
products, and comparing your energy
use. Sixteen workshops were held to
assist homeowners to follow the guid-
elines in the workbook. Copies may be
obtained, while the supply lasts, from:

Project HEAT
Arapahoe County
5334 S. Prince Street
Littleton, Co 80166.
Recent ERIC/SMEAC Publications

Readers wishing to order a copy of any of these publications may either purchase them from the ERIC Clearinghouse for Science, Mathematics and Environmental Education or may order from the ERIC Document Reproduction Service (EDRS), P.O. Box 190, Arlington, VA 22210. Materials ordered from EDRS may be purchased as microfiche or papercopy. Prices and ordering information are found in the document resumes in Resources in Education (RIE) as are order forms.

Environmental Education

Energy Education Programs: Elementary School Programs and Resources
H. L. Coon and J. F. Disinger, compilers
ED 183 386

Fourteen energy education programs in elementary schools are described. An annotated bibliography of energy materials announced in “Resources in Education” and available from ERIC is included.

Energy Education Programs: High School Programs and Resources
H. L. Coon and J. F. Disinger, compilers
ED 193 381

Methods by which selected high schools have integrated energy education into classrooms are described. The 12 case studies contain information about resources used. An annotated bibliography includes information about other curriculum materials.

Water Quality Instructional Resources Information System (IRIS): A Compilation of Abstracts to Water Quality and Water Resources Materials
ED 182 111

Over 1,700 abstracts of print and non-print materials related to water quality and water resources education are contained in this compilation. Entries are included from all levels of governmental sources, private concerns, and educational institutions.

Current Issues V: The Yearbook of Environmental Education and Environmental Studies. Selected Papers from the Eighth Annual Conference of the National Association of Environmental Education
Arthur B. Sacks and Craig B. Davis, editors
ED 180 822

Proceedings are presented in two major sections. Section I contains 12 papers based on original research and thought, providing historical perspective and future projections. Section II contains four descriptive papers and program reviews, intended to be useful and of interest to environmental educators.

Values Activities in Environmental Education
Mary Lynne Bowman
ED 182 118

Class activities for students in grades K-12 provide a variety of approaches to values discussion and clarification. Content involved includes single subject areas or combinations of science, mathematics, social studies, language arts, and fine arts.

An Annotated Bibliography of Environmental Communication Research and Commentary: 1969-1979
Renee Guillierie and A. Clay Schoenfeld
ED 184 852

Significant literature of the environmental communication field is identified and reviewed. Included are (1) background on environmental communication, (2) strategy and tactics of the environmental communication literature review, (3) an index, (4) journal articles, and (5) book abstracts.
Editor's Comments

The third issue of the ERIC/SMEAC information bulletin for 1980 is focused on information related to the topic of safety in the science classroom. Safety is discussed as it relates to teacher responsibility, general safety procedures in the science laboratory, safety procedures for use of chemicals, of microorganisms, of plants and animals, of electricity, of lasers, and of model rockets. References are also provided for sources cited in the bulletin as well as additional useful references for science teachers.

Readers wishing copies of the materials identified in the bibliography and related references sections of this bulletin should check the appropriate issues of Resources in Education (RIE) for ordering information for documents having an ED number. Reprints of some of the journal articles are available from University Microfilms International. Ordering information for UMI reprints is found in Current Index to Journals in Education (CIJE). Sufficient publication information is provided for those materials which are not a part of the ERIC system to enable interested readers to write for copies or for additional ordering information. These reference materials are not available from the ERIC Clearinghouse for Science, Mathematics and Environmental Education.

This material on safety in the science classroom and laboratory was written for this issue by Gary Swietzer, Graduate Research Associate and Information Analyst, Science Education, ERIC/SMEAC.

Who is responsible for the safety of the student in the classroom?

Even though teachers are employed by local school boards and may be directly responsible to building principals and/or area supervisors, it has been ruled that the teacher is not the "servant" or "agent" of the school district in the legal sense of those terms (Brown & Brown, 1969). Therefore, it is the teacher who is directly responsible for the safety of his/her students and it is unlikely that any court would transfer responsibility for a student injury from the teacher to his/her employer. However, before a teacher can be held personally liable for any injuries to students it must be proved that the teacher acted in an illegal or improper manner or neglected to take proper action. This improper conduct could include performance of an act that puts pupils in a hazardous position as well as failure to take appropriate action for student protection. It is the responsibility of the teacher to exercise "reasonable care" in the performance of his/her duties. Reasonable care indicates that the teacher must foresee possible dangers, at least to the extent that any reasonably prudent person would.

What must be done by a science teacher to demonstrate reasonable care for student safety?

As is the case with many aspects of instruction, the planning phase is very important in establishing reasonable care. In planning teacher demonstrations or student experiments, the activity should be examined against a criterion of educational merit versus hazard potential. Once the hazards have been identified, steps must be taken to alert students to the hazards and to make them aware of the proper safety procedures.

A simple posting of instructions or rules has been held by the courts to be insufficient. To demonstrate reasonable care the teacher must remind the students of the general safety instructions and provide any appropriate specific instructions before each activity. The teacher cannot rely on general instructions given at an earlier time. During the course of the activity it is the teacher's responsibility to provide adequate supervision including the selection and use of the designated chemicals. A teacher who must leave the room for a chemical or item of equipment that was inadvertently omitted leaves himself/herself open to charges of negligence.

The concept of reasonable care also extends to activities such as field trips and independent student projects. In the case of field trips a teacher visitation to the site prior to the trip to determine possible hazards and to forewarn the students is appropriate in addition to general rules for safe conduct before the trip. Individual student projects, whether they are for a classroom project or a science fair, should be given a thorough safety check. During the planning phase of the project students should be thoroughly questioned concerning the safety precautions taken in working on the project and any specific hazards that the project may pose. Any project which will be viewed by the public should be constructed so that observers are protected from possible accidents.

Many teachers find it expedient to use students to run errands both on and off of school property. It is possible that the student would be considered an agent of the teacher and liable for any damage caused by the student or injury to the student would be assessed on the teacher. This practice should, therefore, be avoided.

What are some general safety procedures for the science laboratory?

Conduct a periodic classroom inspection to identify the location and condition of fire extinguishers, first aid kits, showers, and eyewash. General goodhousekeeping should be maintained including the proper storage of materials and equipment.

Be aware of proper accident procedures, fire precautions, and evacuation routes.

Be aware of federal, state, and local regulations which relate to school safety.

Make spill packages available, have metal containers for the disposal of broken glass, and maintain a sand-filled container for the disposal of matches.

Be aware of the location of the main utility shut-off valves and switches for water, gas, and electricity.

Maintain hazardous materials under lock and key at all times. Maintain only minimum amounts of chemicals in the classroom. Lock all laboratory and storage facilities when they are not under direct supervision.

Properly label and date all reagent bottles.

Guard against poisoning by providing adequate ventilation for volatile substances, by providing instruction on the avoidance of ingestion of chemicals or
plants, by identifying dangerous plants and animals, and by providing safeguards against radioactive contamination.

Provide shielding for the teacher and students for demonstrations involving the possible explosion or implosion of apparatus or the possibility of injury due to spattering.

Provide sufficient time for students to set up the equipment, perform the experiment, and properly clean-up and store the materials after use.

Set a good example when performing all demonstrations.

Instruct students concerning specific hazards and precautions at the beginning of each science activity.

Obtain certification in First Aid from the American National Red Cross.

Establish group size appropriate for efficient performance of the exercise without confusion.

Instruct students never to eat or drink in the laboratory and never to use laboratory glassware as a food or drink container.

Demand that chemical goggles be worn in any situation that is a potential source of splashes, spills, or spattering (hazardous chemicals, hot liquids or solids, radioactive materials).

Instruct students never to perform an unauthorized experiment or to use unauthorized equipment or materials.

Caution students to exercise care in noting odors and never to taste, touch, or smell substances without specific instructions from the teacher.

Do not permit students to touch laboratory equipment until instructed to do so.

Perform demonstrations or experiments before allowing students to replicate the activity. Identify hazards related to the procedures, equipment, and materials.

Instruct students never to pipette chemical reagents by mouth.

Instruct students never to force glass tubing into a cork or stopper.

Instruct students to slant test tubes away from themselves when heating them and never to discard matches in the sink. Remind students of the low visibility of burner flames and have them exercise caution regarding long hair and loose clothing.

Have students keep materials other than lab manuals and/or notebooks away from the working area.

Instruct students that it is unsafe to touch the face, mouth, or eyes or other parts of the body after working with plants, animals, or chemicals until they have washed their hands thoroughly.

Provide adequate supervision of the laboratory at all times.

What are some specific safety procedures with regard to chemicals?

In addition to the safety procedures for each exercise or experiment, the safe use of chemicals involves four major areas. The teacher should be aware of proper storage procedures, proper disposal techniques, chemical toxicity, and unstable or incompatible chemical combinations.

The proper storage of chemicals should provide security against unauthorized removal of the chemical, protect the environment by restricting chemical emissions, and protect the reagents from fire. The room used for this storage should be well ventilated, dry, and protected from sunlight and localized heat such as hot water pipes. The room should always be kept locked when not in use.

Liquid flammables should be stored in a separate metal cabinet. This includes such items as gasoline, kerosene, methyl acetate, methyl alcohol, ethyl ketone, petroleum ether, propyl alcohol, pyridine, toluene, turpentine, and xylene. Oxidizer storage should also be in a separate cabinet which is light-tight and lockable. Chemicals stored here would include ammonium nitrate, potassium chlorate, potassium nitrate, potassium permanganate, sodium nitrate, and metallic sulfates or permanganates.

Control storage (lockable) should be provided for the remainder of the chemicals. Metallic sodium or potassium must be stored under kerosene and containers of sodium, potassium, calcium, or calcium carbide should not be stored above water solutions or containers of water. White phosphorus must be stored and cut under water and the water changed occasionally as it becomes acidic.

Special care should be exercised in the storage and use of ether. Ether reacts slowly with oxygen to form peroxides that are explosive. These unstable peroxides are less volatile than ether and have a tendency to concentrate. For maximum safety ether should be procured in quantities that will be used once opened.

In many school laboratory hoods are used for storing chemical reagents. Storage of volatile or flammable materials in a hood necessitates that the hood operate continuously; most hoods are not designed to function in this manner. Hood storage often results in a corrosive atmosphere which leads to label deterioration. Furthermore, hood storage causes the loss of valuable laboratory space, has no security provisions, and may create hazards due to the presence of incompatible chemicals. Use of a hood for storage should be discouraged.

Often a stockroom refrigerator of the commercial home type is used for storage. This creates a hazard when certain flammable or explosive materials are stored in it. This type of refrigerator has numerous open type switches which can spark and ignite explosive vapors. If a refrigerator is used for this purpose it should be of the laboratory grade explosion-proof variety.

All materials should be stored in containers that are easily handled and resistant in the case of corrosives. A detailed list of chemicals and their proper storage containers is available in Safety in the Science Laboratory (Christian, 1968), and Safety in the Secondary Science Classroom (NSTA, 1978).

A purchasing philosophy dictated solely by economic considerations can create storage problems. While bulk rates usually result in less unit expense, chemicals should not be purchased in such quantities that they will not be used in a reasonable amount of time. Before any chemical is stored, the label should be checked to ensure that it clearly states what the material is, the type and severity of any associated hazards, precautionary and treatment procedures for the hazard, and the date it was received.

The second area relative to the safe use of chemicals involves proper disposal techniques. The importance of protecting our environment from chemical pollution negates the wholesale use of dilution to dispose of chemicals down the drain. Small amounts of dilute acids, bases, or salt solutions may be flushed down the drain with large amounts of water, but be sure that all materials are water soluble, non-toxic, and in concentrations well below the threshold limit.

Solid materials that can not be flushed because of their insolubility or toxicity should be disposed of in crockery storage jars with protective lids. Flammable solids should not be placed in these containers. Once the waste is collected it can be disposed of in a land fill or other appropriate technique as indicated in the publication Laboratory Waste Disposal Manual by the Manufacturing Chemists Association (1973). A partial list of materials that can be disposed of in a land fill or released to the air follows:

- Argon
- Asphalt
- Batteries, dry cell
- Boron
- Bromochloromethane
- Calcium carbonate
- Calcium oxide
- Carbon black
- Carbon tetrachloride
- Chlorobromomethane
- Chromium
- Crude lime
- Dibromomethane
- Epoxy resin systems
- Ferrosilicon
- Helium
- Hexachloroethane
- Hexafluoroethane
- Hydrogen
- Lamp bulbs
Latex
Magnesium oxide
Metal scrap
Molybdenum, insoluble compounds
Neon
Nitrogen
Nitrogen fertilizers
Nitrogen trioxide
Osmium tetroxide
Oxygen
Ozone
Paint
Pyrethrum
Resins
Rubber
Scrap glass
Scrap stoneware
Silica
Sludges
Stone, alberine
Sulfur
Sulfur hexafluoride
Tar
Tetrabromoethane
Tir, organic compounds
Titanium oxide
Tremolite
Trifluoromethane
Urea
Xenon
Yttrium
Zinc oxide

The third area relates to chemical toxicity; toxic referring to those materials that cause damage to humans. A representative classification of the level of health hazard is as follows: nuisances, irritants, corrosives, anesthetics, allergens, carcinogens, mutagens, teratogens, toxins, and central, nervous system depressants. Very often the safety hazard of a chemical is enumerated and its potential as a health hazard ignored. Carbon disulfide wherein its volatility and flammability are emphasized is an example in that carbon disulfide is also highly toxic, possibly causing damage to the liver, kidneys, and central nervous system. Chemical entry to the human organism occurs through the digestive tract, respiratory tract or skin. The respiratory tract is the most common entry pathway. A partial list of substances whose fumes or dust are toxic when inhaled is as follows:

- Acetic acid (concentrated)
- Ammonium hydroxide
- Benzene
- Bromine
- Carbon disulphide
- Carbon monoxide
- Carbon tetrachloride
- Chlorine
- Formic acid
- Hydrochloric acid
- Hydrofluoric acid
- Hydrogen sulfide gas
- Mercury
- Nitric acid
- Nitrogen oxides
- Plastics
- Perchloric acid
- Potassium hydroxide
- Sodium hydroxide

Many of these chemicals have more than one name. An article by J. Bradford Block, M.D., contains a list of these carcinogens and their synonyms. This was published in the September 1976 issue of the Journal of College Science Teaching. The list is also available from your local chapter of the American Lung Association. As a companion to this list of known carcinogens, the National Institute for Occupational Safety and Health (NIOSH) has published a list of suspected carcinogens. This list is available through the Division of Technical Services, NIOSH, Cincinnati, Ohio, 45226. Any of the substances on these list should be eliminated from the school laboratory.

The fourth area relative to the safe use of chemicals relates to unstable and/or incompatible chemical combinations. Frequent accidents occur because neither the student nor the instructor is able to anticipate the results of certain chemical combinations. This is not uncommon among experienced chemists. Instructors should have available a list of unstable and incompatible combinations. A partial list of unstable chemicals and their properties is as follows:

- Ether—easily forms explosive peroxides
- Ammonium nitrate—decomposes exothermically above 160 degrees Celsius, producing a large volume of gaseous products containing hydrochloric acid
- Formic acid—concentrated, it is unstable and has been known to explode
- Phosphorus-white—spontaneously ignites in air at temperatures above 30 degrees Celsius
- Ammonical silver nitrate solutions (Tollen's reagent) — may produce unstable products which detonate violently when disturbed
- Benzaldehyde—extremely unstable
- Nitrogen tri-iodide—dangerous when dry
- Picric acid, metal picrates, perchloric acid—very unstable

A partial list of incompatible chemical combinations is as follows:

### Incompatible Chemicals

<table>
<thead>
<tr>
<th>Compound</th>
<th>Incompatible Chemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic Acid</td>
<td>Nitric acid, peroxides, permanganates, ethylene glycol, hydroxyl compounds</td>
</tr>
<tr>
<td>Acetone</td>
<td>Concentrated nitric and sulfuric acid mixtures</td>
</tr>
<tr>
<td>Alkali metals; e.g., sodium or potassium</td>
<td>Carbon tetrachloride, carbon dioxide, water, hydroxyl compounds</td>
</tr>
<tr>
<td>Ammonia, anhydrous</td>
<td>Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrochloric acid (anhydrous)</td>
</tr>
<tr>
<td>Ammonium nitrate</td>
<td>Acids, inflammable liquids, metal powders, sulfur, chlorates, any finely divided organic or combustible substance</td>
</tr>
<tr>
<td>Aniline</td>
<td>Nitric acid, hydrogen peroxide</td>
</tr>
<tr>
<td>Bromine, chlorine</td>
<td>Ammonia, petroleum gases, hydrogen, sodium, benzene, finely divided metals</td>
</tr>
<tr>
<td>Chlorates</td>
<td>Ammonium salts, acids, metal powders, sulfur, any finely divided organic or combustible substance</td>
</tr>
<tr>
<td>Chromic acid</td>
<td>Acetic acid, naphthaline, camphor, glycine, turpentine, alcohol, flammable liquids in general</td>
</tr>
<tr>
<td>Flammable liquids</td>
<td>Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, the halogens</td>
</tr>
</tbody>
</table>
should be placed between the liquid and the mouthpiece. The production of aerosols should be minimized by always discharging the pipette below the surface of liquids and by never bubbling air into a liquid nor forcefully ejecting the liquid from the pipette. Used pipettes should be immediately placed in a disinfectant solution and autoclaved before reuse. Accidental syringe inoculation can be avoided by ensuring proper animal restraint during injection. Again, reduce laboratory aerosols by discharging any liquids below the surface of the receiving medium and not by expelling excess liquid into the air. In using an inoculating loop, avoid aerosol production by allowing the loop to cool before insertion into the medium and by avoiding sudden movements that break the loop film. A centrifuge is often used to separate cell suspensions from the medium. All tubes should be inspected to guard against breakage, and the centrifuge cups should be filled with disinfectant as a precaution should breakage occur.

In sampling for microorganisms to inoculate cultures, be aware of the presence of tetanus in soil samples, or typhoid, botulism, and schistosomiasis organisms in standing water and ditches. Exercise care not to contaminate the culture by coughing or sneezing or by prolonged exposure to the air. Care should be taken that excessive distribution of spores and pollen does not occur in the classroom because of possible allergic reactions. Culture dishes that are passed around the classroom or left out for viewing should be taped closed. If a culture is accidentally spilled, the area should be cleaned with a strong disinfectant. All old cultures should be autoclaved before disposal. Liquid disinfectants are useful but should not be relied on for complete sterilization.

**What are some specific safety procedures and guidelines when working with plants and animals?**

The use of living organisms, both plants and animals, in the classroom can be a motivational tool as well as a vehicle for understanding the concept of life and life processes. The use of living organisms does, however, introduce another spectrum of potential hazards and a new list of teacher and student responsibilities.

All plants have not been thoroughly researched relative to their toxicity. Different parts of the same plant can have different properties. Therefore, in working with plants, never place any part of the plant in the mouth or rub the sap on the skin. Avoid inhalation or exposure of the skin and eyes to smoke from any burning plant or plant parts. Be knowledgeable of the proper recognition procedures for plants. Never pick any strange wild flowers or cultivated plants unknown to you. The following list from the *Oakland County Science Safety Series Reference Guide for Biology* (1977) indicates some plants known to cause reactions:

- **Apple trees** — seeds
- **Autumn crocus, Star-of-Bethlehem** — bulbs
- **Baneberry** — berries
- **Black locust** — bark, sprouts, foliage
- **Bleeding heart** (Dutchman’s breeches) — foliage, roots
- **Crab apple** — foliage, seeds
- **Daphne** — berries
- **Death camas** — all parts
- **Diefenbachia (Dumb cane)**, Elephant ear — all parts
- **Eggplant** — all parts except fruits
- **English holly** — berries
- **Foxglove** — leaves
- **Golden chain** — bean-like capsules in which the seeds are suspended
- **Honeysuckle** — seeds
- **Horsechestnut** — leaves, flowers and seeds
- **Hyacinth, Narcissus, Daffodil** — bulbs
- **Iris** — underground stems
- **Jack-in-the-Pulpit** — all parts, especially roots
- **Jassamine** — berries
- **Jimson weed (thorn apple)** — all parts
- **Lantana camary (red sage)** — green berries
- **Larkspur** — young plant, seeds
- **Laureus, Rhododendron, Azaleas** — all parts
- **Lily-of-the-Valley** — leaves, flowers
- **Maidenhair trees (Ginkgo biloba)** — fruit
- **Marsh marigold (uncooked)** — all parts, sap
- **Mayapple** — green apple, foliage, roots
- **Mistletoe** — berries
- **Monkshood (wolfsbane)** — fleshy roots
- **Moonseed** — berries
- **Mushrooms** — all parts
- **Nightshade** — all parts, especially the unripe berry
- **Oak trees** — foliage, acorns unless properly prepared
- **Oleander** — leaves, branches
- **Peach trees** — leaves
- **Pear trees** — leaves
- **Plum trees** — leaves
- **Poinsettia** — leaves
- **Poison oak, ivy, Nettles, Common buttercup** — all parts
- **Pokeweed** — berries and roots
- **Potato** — vines and foliage, green tubers
- **Privet, common** — berries and leaves
- **Rosary pea, Castor bean** — seeds
- **Rubarb** — leaf blade
- **Toadstools and related fungi** — all parts
- **Tomato** — vines, foliage
- **Water hemlock** — all parts
- **White snakeroot** — foliage
- **Wild carrot** — foliage
- **Wild cucumber** — seeds
- **Wild and cultivated cherry trees** — twigs, foliage
- **Wild radish** — flowers, fruits, stalks
- **Wisteria** — seeds, pods
- **Yew** — all parts

When working with seeds, be aware that a student may consciously or unconsciously place a seed in his or her mouth. This may create a danger from ingestion of the seed itself or from a coating of hormone, fungicide, and/or insecticide. Seeds should always be inspected for such coatings. When working with pollen or spore producing plants, avoid unnecessary dissemination of pollen grains and spores which can result in bronchial inflammation and other allergic responses.

In working with animals in the laboratory, the teacher should be aware of the psychological ramifications of animal experiments, in addition to the safety procedures, and take steps to alleviate any misunderstandings. This necessitates that an adult supervisor assume the primary responsibility for all experiments involving animals. Be aware that some states require special certification before teachers are permitted to experiment with animals. Furthermore, the teacher should take precautions to ensure that all animals used for experimental purposes are lawfully acquired and kept in strict compliance with federal, state, and local laws and regulations. The teacher or qualified assistant should be in charge of the pithing of frogs and the general sedation of all animals.

All animals must receive humane treatment. Animals should be caged so as to avoid animal bites to students and to protect the animals from improper handling by students. Students should be instructed in the proper handling procedures and should wear protective gloves and/or clothing as appropriate. Be aware of the special handling requirements necessary if the animal is pregnant, with young, or hungry. Treat any scratches or bites that are incurred promptly and isolate the animal for ten days. The animal care facilities should be cleaned frequently enough to remove animal wastes, control vermin, and keep the concentration of pathogenic microorganisms at a minimum. Optimum housing conditions for the various species should be maintained, including proper diet and sufficient water. Cold-blooded animals should be returned to a care facility that approximates their natural environment as soon as possible after handling, and turtles should be handled as little as possible because they may carry salmonella. Poisonous snakes, snapping turtles, disease-carrying insects, and harmful spiders should not be kept in the classroom. In animal experiments that animals should not be subjected to stress, pain, or discomfort. Deficiency experiments should be conducted only to the symptomatic stage and should cease before debilitating the animal. No surgery should be performed on any living vertebrate. Eggs that have been manipulated during development should not be allowed to hatch. Obtain all animals from a reputable supply house; avoid bringing wild animals into the classroom. Any disposal of animals should be accomplished in a humane fashion out of sight of the students.

The National Science Teachers Association has established a code of practice on using animals in the classroom. The details of this code can be found in the September, 1980 issue of The Science Teacher.

Disease control is another area of responsibility in caring for animals. Diseases can be transmitted among animals, from animals to humans, and from humans to animals. Animals can contract salmonellosis, influenza, tuberculosis, and infectious hepatitis from humans. Humans can contract many diseases from animals. Instructors and students should be aware of danger signs that may indicate disease. These danger signs include an unusual odor emanating from the cage, a sluggish or unresponsive animal, constant or unusual bickering among inmates, loss of appetite, an unhealthy pallor or color change in hair, eyes, or skin, unusual discharge from body openings, or frequent sneezing. An animal suspected of disease should be isolated, its quarters disinfected, and if the diseased condition persists, humanely destroyed.

What are some specific safety procedures when using electricity?

The basic hazard when using electricity is that of being subjected to electrical shock. Electrocutation can occur under a variety of circumstances. It is actually the amount of current that flows through the body that determines the severity of the shock. Severe shock hazards can therefore exist even when using relatively low voltages. The amount of current flowing through the body is determined by the interaction of the factors expressed in Ohm's law:

\[
\text{current} = \frac{\text{voltage}}{\text{resistance}}.
\]

Therefore, with a constant voltage, the current that flows through the body increases as the resistance decreases. The body has a fairly low resistance but the skin has a high resistance, about 500,000 Ohms. Conditions that allow more than 10 milliamperes to flow through the body will cause a painful shock. Conditions that result in a flow of from 100 to 200 milliamperes may cause severe burns and unconsciousness. This is usually not fatal if treated promptly. Conditions that result in a current flow above 200 milliamperes are usually fatal. The severity of the shock is also related to the nature and area of the contact surface, the time of contact, and the pathway that the current takes through the body.

Electrical safety procedures involve controlling the above factors so that electric current does not flow through the body. Even a normal 110 volt power line can be very dangerous. Electrical circuits and equipment should only be handled with dry hands. Moisture on the skin reduces its resistance from about 500,000 ohms to 1,000 ohms, creating a shock hazard. Electrical equipment should only be handled on a nonmetallic floor. Rubber mats are preferable and the floor must be dry. The teacher or students should be sure that the person is not grounded nor in contact with any grounded items. The following is a partial list of additional procedures:

1. Test all electrical equipment for leakage and refrain from using equipment that produces even a slight shock. Check electrical equipment for approval by the Underwriter's Laboratories or some other recognized testing lab.

2. Shield all live electrical switches and connections, clearly label all switches and circuit breakers for the open and closed positions, and be aware of the location of the main breaker for the laboratory circuits.

3. Do not touch circuit parts with the power on. Use tools with insulated handles, and check all circuits used by students before current is allowed to flow.

4. When assembling circuits connect the live portion last; when disassembling disconnect the live portion first.

5. When plugging in equipment beware of sparks from a possible short circuit. When removing plugs pull by the plug, not the cord.

6. Do not connect appliance, equipment, or extension cords to light sockets. Make sure that all electrical appliances and equipment are properly grounded.

The major information sources for the above were the Oakland County Reference Guide for Physics and Physical Science (1977) and Safety in the Secondary Science Classroom (NSTA, 1978). An additional source is the Modern Chemical Technology Guidebook for Chemical Technicians, American Chemical Society, Washington, DC (1970).

What are some specific safety procedures when using lasers?

The main hazard when working with lasers involves possible injury to the eye. Even low laser power can cause retinal burns. If the area involves the macula, fovea, or optic nerve, severe permanent damage may result. Additional laser hazards involve the potential for first and second degree burns as a result of exposure to beams from high-powered solid state or junction lasers. Electric shocks and burns may result from inadvertent contact with the input power or from a capacitor discharge. X-rays may be given off by some equipment. Burns can
Potential hazards of laser beams to the eyes are dependent on the laser power, beam diameter, distance from the beam, the color of the light, the angle of the beam, the focal length of the eye, and the diameter of the eye opening. Therefore, the optical power should be reduced to the lowest level necessary to accomplish the instructional objective, with a .5 milliwatt Helium-Neon laser being the maximum required for high school demonstrations. The general illumination of the room should be kept high so that the pupils of the eyes are not dilated. All optical components should be rigidly fixed. All reflective objects should be removed from the anticipated laser path. All personnel should remain away from the sides of that path. A cover should be used to block the beam when it is not in use. Security should be provided by equipping the primary circuit with a key switch. If at any time the interaction of the above stated factors exceeds threshold limits, glasses certified as protection for lasers should be worn. The Oakland Reference Guide for Physics and Physical Science (1977) indicates that exposure of the retina to radiation of one millijoule per cm² for one millisecond from a ruby laser has caused retinal burns. For additional procedures see the Handbook of Laboratory Safety. The Chemical Rubber Company, Cleveland, Ohio (1971).

What are some specific safety procedures when using model rockets?

The Federal Aviation Agency has established regulations concerning the launching of model rockets launching of model rockets (see Moored Balloons, Kites, Unmanned Rockets, and Unmanned Free Balloons (Department of Transportation)). Some states have enacted laws regulating model rocket launching. Laws and regulations address such items as rocket design, construction and weight, and propellant type and amount. In all cases rockets must be operated so as not to create a hazard to persons, property or other aircraft. The following guidelines were adopted from the Oakland County Reference Guide for Physics and Physical Science (1977):

1. The total rocket weight, including the engine, should not exceed 16 ounces.
2. There should be not more than 4 ounces of fuel in the rocket engine at the time of launch.
3. The rocket should be designed for re-use with a system to slow the rocket's return and thus minimize damage.
4. The rocket should be constructed for maximum in-flight stability with a minimum of metal parts.
5. The rocket should not contain an explosive or pyrotechnic warhead.

The engine should be commercially prepared with all fuels already mixed. The engine should be incapable of igniting or exploding at temperatures of less than 170 degrees F. Spontaneous combustion should not occur in air, underwater or when subjected to shock or pressure.

7. The launch area should include 5,000 square yards and, when approximating a rectangle, have no side less than 50 yards. The flight area should be free of high voltage lines, major highways, water towers, multi-story buildings, and other obstacles.

8. Launch ignition should be accomplished electrically by remote control. Persons in the launch area should be warned when the launch is imminent.

9. Rockets should not be launched in cloud cover or at night. At launch time the wind speed should not exceed 20 miles per hour and visibility should be less than 2,000 feet.

10. A launch area can not be used if it is within four miles of the boundary of any airport.

11. The launch angle should be between 60° and 90° from the horizon. An adult should inspect the rocket and launch area prior to flight and supervise the launch.

12. The rocket can not be used for a fireworks display.

13. Unmanned rockets cannot be launched unless proper notice has been given to the Federal Aviation Agency Air Traffic Control facility as indicated by F.A.A. regulation Volume VI, Sec. 101.25.

Bibliography


Additional References

Recent ERIC/SMEAC Publications

Readers wishing to order a copy of any of these publications may either purchase them from the ERIC Clearinghouse for Science, Mathematics and Environmental Education or may order from the ERIC Document Reproduction Service (EDRS), P.O. Box 190, Arlington, VA 22210. Materials ordered from EDRS may be purchased as microfiche or paper copy. Prices and ordering information are found in the document resumés in *Resources in Education* (RIE) as are order forms.

Science Education

Review of Research: Teacher Questioning Behavior in Science Classrooms
Patricia E. Blosser ED 184 818

Dissertations and other research reports related to science teacher questioning behavior are analyzed. Research is summarized separately for observational studies and experimental studies.

1980 AETS Yearbook: The Psychology of Teaching for Thinking and Creativity
Anton E. Lawson, editor ED 184 894

The focus of this yearbook is on the relationship of teaching thinking and creativity in a science education context. Following a foreword by Piaget are 11 chapters by Roger Gagne, Constance Kamii, Robbie Case, A. E. Lawson and C. A. Lawson, Robert Karplus, D. P. Aussenbeyl, J. D. Novak, E. P. Torrence, J. A. Vargas and P. A. Moxley, and M. A. Mogus.

Alan J. McCormack, editor ED 183 374

Ideas for outdoor learning activities appropriate for youngsters in elementary, middle and junior high schools are presented. These activities are designed to assist the teacher in using outdoor areas surrounding the school as a laboratory for effective instruction.

National Association for Research in Science Teaching 53rd Annual Meeting, Abstracts of Printed Papers
Arthur L. White, editor ED 182 116

Abstracts of papers presented at the 1980 meeting relate to research techniques, learning, cognitive development, instruction, science curriculum, teacher education (preservice, in-service), and other topics.

SOME FREE, USEFUL MATERIALS ABOUT ERIC®

From time to time, people who visit the ERIC display at some educational meeting express surprise when they see materials about ERIC which are free for the asking. As a service to readers, we have included a form to be completed and returned in order to receive some, or all, of these materials.

Available materials include a listing of ERIC microfiche locations by state, a list of computer search services available by state, "A Short Guide to ERIC and ERIC/SMEAC," and the publications list from the ERIC Clearinghouse for Science, Mathematics and Environmental Education.

Information about ERIC microfiche locations includes the address of the collection and hours it is available for use, telephone number to call and name of individual in charge of the collection, status of the collection (years of microfiche included) and equipment available for use, as well as reproduction services available.

For computer search services, the address, telephone number and name of the person to contact are also given. Additional information includes the approximate cost of a search, length of time needed to produce the search as well as files to be searched and the format in which the search question must be structured.

Please complete the form on the back of the next page and mail it to:
ERIC/SMEAC Information Reference Center
1200 Chambers Road, Room 310
Columbus, Ohio 43212
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NAME ____________________________________________

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Please send me (indicate materials desired):

______ List of ERIC microfiche locations in my state

______ List of computer search services in my state

______ A Short Guide to ERIC and ERIC/SMEAC

______ ERIC/SMEAC publications list

ERIC® Clearinghouse for Science, Mathematics, and Environmental Education
The Ohio State University
1200 Chambers Road, 3rd Floor
Columbus, OH 43212
4230-710946

ADDRESS CORRECTION REQUESTED
Editor's Comments

The three previous 1980 issues of the ERIC/SMEAC information bulletin have been focused on a single theme for each issue reflecting a concern of one of the areas within the scope of the Clearinghouse: science education, mathematics education, or environmental education. This fourth, annual, issue may be said to have a theme, also, in that much of the material relates to activities of the ERIC system in general and to those of ERIC/ SMEAC in particular.

It is of particular importance that readers of this bulletin read carefully (rather than scan) the information dealing with changes in distribution procedures of Information bulletins and fact sheets. In the past the editor has received letters and telephone calls from persons concerned by the fact that they had not received an issue within the time span they had anticipated for another mailing and wanted to make certain they were still on the ERIC/SMEAC mailing list. The standard response was an apology and a brief explanation that other duties took priority over production of another issue of the Information bulletin but that one would be in print in the near future and they would receive a copy. From this point on, that explanation is no longer a valid one. If readers fail to complete the form on the last page of the bulletin and do not mail it to ERIC/SMEAC, their earlier assumption will be true: their names and addresses will no longer be on the ERIC/SMEAC mailing list. Also, please take notice of the fact that there is a subscription cost involved if present recipients of the ERIC/SMEAC Information bulletin are to receive all four issues produced each year.

Recent ERIC/SMEAC Information Analysis Products

Each of the Associate Directors of the ERIC Clearinghouse for Science, Mathematics, and Environmental Education (Drs. Helgeson, Suydam, and Disinger) was asked to identify several documents produced by the Clearinghouse in 1979-1980 to be highlighted for the readers of this bulletin. This highlighting has taken the form of an expanded descriptive abstract of the document.

Science Education

Outdoor Areas as Learning Laboratories, CESI Sourcebook

Alan J. McCormack, compiler and editor

This sourcebook which describes practical and exciting activities to supplement and enrich science programs is focused on using outdoor sites as laboratories. School site laboratories were chosen because right there, where teachers are, are opportunities to study the environment while practicing investigatory skills. The contributors believe that learning is enhanced when children can directly touch, see, and explore for themselves. The key is to find some interesting problems that children can investigate in their local environment. The book is intended to be a source of ideas for outdoor learning activities appropriate for youngsters in elementary, middle and junior high schools. It may also be useful for anyone who works with children in outdoor settings: camp counselors, boy/girl scout leaders, park recreation specialists, nature interpreters.

These "kid-tested" activities have been grouped into animal studies, plant studies, ecology activities, physical science activities, and interdisciplinary activities. An appendix contains plans for building instruments (dipmeter, CESI bug catcher, wind vane, anemometer, human hair hygrometer, aquatic sampling tools) to use in outdoor studies. ERIC/SMEAC price: $6.50 (ED 183 374)

The Psychology of Teaching for Thinking and Creativity

Anton E. Lawson, editor

Part of the AEET yearbook series, this volume provides a single forum for the presentation of the prominent psychological views on the development of the
intellect and how instruction can assist in this most significant development.

Authors who contributed chapters to this yearbook were asked to read The Central Purpose of American Education, produced in 1961 by the Educational Policies Commission of the National Education Association. In this small volume, the essence of the ability to think is characterized as involving the rational processes of recalling and imagining, classifying and generalizing, comparing and evaluating, analyzing and synthesizing, and deducing and inferring. Each author was asked to respond to six questions at some point in his/her chapter so that areas of agreement and disagreement among authors could be identified.

Piagetian, Neo-Piagetian, Gagneian, Ausubelian, and Skinnerian points of view are presented, as is a chapter reflecting the point of view of Humanistic psychologists. In addition there are chapters dealing with creativity, with current areas of psychological research, and with split-brain research.

ERIC/SMEAC price: $7.00 (ED 184 894)

Science for the Handicapped,
An Annotated Bibliography
Ben Thompson, editor

This annotated bibliography represents, for the first time, a single source of information on science education for the handicapped. Entries are grouped under the following headings: The Visually Impaired-General, The Visually Impaired-Research, The Hearing Impaired-General, The Hearing Impaired-Research, Other Handicapping Conditions-General, and Other Handicapping Conditions-Research.

Materials identified include journal articles, books, and papers presented at regional and national meetings. Some foreign language entries are included. ERIC/SMEAC price: $3.50 (SE 033 907)

Mathematics Education

Interactions of Science and Mathematics
Peggy A. House

This publication includes 47 investigations "...for every science teacher whose students have moaned about the mathematics involved, and for every mathematics teacher whose students have asked 'Why do we need to know this?'"

The author emphasizes:

a. patterns which we observe in selected physical situations;
b. variables and other mathematical symbols which we use to represent patterns;
c. functions which describe the relationships among quantities or objects — these include both numerical and spatial relationships;
d. measurement and the gathering, organizing, communicating, and using of data; and
e. models or abstractions which enable us to explain, to predict, and to make decisions.

Many of the investigations are commonly included in junior and senior high school science laboratory activities. The required equipment is easy to assemble or typically available from school science departments. Each investigation also deals with one or more important mathematical concepts found in junior and senior high school curricula. The activities can be conducted during typical class periods and adapted to meet the needs of a teacher's own students.

ERIC/SMEAC price: $6.00 (SE 033 191)

International Calculator Review
Marilyn N. Suydam

The current status of calculator use in sixteen countries is reviewed in this publication.

Comments on the following issues are included in the individual national reports:

- At what levels should calculators be used?
- How should calculators be used — as computational tools and/or instructional aids?
- Should calculators be used on tests?

In addition, the reports discuss:

- Trends, predictions, and prevailing opinions about curricular implications of calculators
- Research activities with calculators
- Instructional practices
- Student outcomes, attitudes, and concerns
- In-service activities for teachers
- General background on amount of use, type of use, projects, etc.

This review also includes a list of selected references, a report of the International Working Group on Calculators, and comments synthesizing the individual national reports. ERIC/SMEAC price: $3.00 (SE 033 190)

Environmental Education

A Directory of Projects and Programs in Environmental Education for Elementary and Secondary Schools, Fifth Edition
John F. Disinger, compiler-editor

Exemplary projects and programs related to K-12 education are presented in this book, based on recommendations from environmental education specialists from 49 state education agencies. Directors of the projects and programs were invited to submit reports, based on a questionnaire, concerning their efforts. This volume contains the 284 responses that were received. Foci of various efforts include conservation education, outdoor education, natural resources management, energy education, population education, marine and aquatic education, and urban environmental education. Information included relates to goals, objectives, program, staffing, funding, history, materials produced, and plans for the future. ERIC/SMEAC price: $16.00 (ED 187 515)

Strategies and Activities for Using Local Communities as Environmental Education Sites
Charles E. Roth and Linda G. Lockwood

More than 100 activities in which the local community is used as a learning site and resource are presented in this book. Activities are appropriate to both classroom and less formal educational settings. Among the learning strategies employed are field trips, community inventories, simulations, value clarification activities, and community action projects. Intended for nine through eighteen year old students, these activities have been compiled from currently available materials. Appendices include listings of reference materials and sources of community information. ERIC/SMEAC price: $5.50 (SE 033 190)

Teaching Basic Skills through Environmental Education Activities
Mary Lynne Bowman

Classroom activities for students in grades K-12 provide a variety of approaches to using environmental education content and examples in the teaching of basic skills. Particular attention is paid to language arts and mathematics. The philosophy espoused is that environmental education is not a discrete area of study but, instead, involves a number of disciplines and provides appropriate focal points and examples for all curricular areas. ERIC/SMEAC price: $4.00 (SE 033 691)

Current Issues VI: The Yearbook of Environmental Education and Environmental Studies. Selected Papers from the Ninth Annual Conference of the National Association for Environmental Education (Albuquerque, 1980)
Arthur B. Sacks, Lei Lane Burrus-Bammel, Craig B. Davis, Louis A. Ioaggi, editors

Following a foreword by Lynton K. Caldwell, papers are presented that were selected from those given at the 1980 conference. The papers are arranged in two sections. The first section contains 10 descriptive papers while the second section contains 22 papers based on original research and thought. Among the areas addressed are energy and transportation, environmental educa-
Readers wishing to order a copy of any of these publications may either contact the ERIC Clearinghouse for Science, Mathematics and Environmental Education and order directly from the Clearinghouse or purchase the publications from the ERIC Document Reproduction Service (EDRS), P.O. Box 190, Arlington, VA 22210. Materials ordered from EDRS may be purchased as microfiche or as paper copy. Prices for microfiche or paper copy are quoted in the document resumes in Resources in Education (RIE). Clearinghouse documents with SE numbers have been sent to EDRS for inclusion in some future issue of RIE. When the document resume appears in RIE, it will have an ED number in addition to its SE number.

ERIC/SMEAC prices for these documents are for pre-paid orders. There is an additional postage-and-handling charge for orders which must be billed to some individual or organization.

ERIC Clearinghouse Network

As most readers of this bulletin know, ERIC is an acronym for the Educational Resources Information Center, which is not really a center but is, rather, a nationwide network of 16 clearinghouses under the direction of the National Institute of Education (NIE). Each clearinghouse specializes in a particular area of education and works with Central ERIC in NIE to form a national information system. The clearinghouses and their addresses and phone numbers are listed below.

ADULT, CAREER, AND VOCATIONAL EDUCATION
The Ohio State University
Center for Vocational Education
1980 Kenny Road
Columbus, Ohio 43210
(614) 466-3655

COUNSELING AND PERSONNEL SERVICES
University of Michigan
School of Education Building, Ann Arbor, Michigan 48109
(313) 763-3650

EDUCATIONAL ADMINISTRATION
Elementary and Early Childhood Education
University of Illinois
College of Education
131 South Sixth St.
Champaign, Illinois 61820
(217) 333-1388

EDUCATIONAL MANAGEMENT
University of Oregon
Eugene, Oregon 97403
(503) 688-5043

HANDICAPPED AND GIFTED CHILDREN
Council for Exceptional Children
1900 Association Drive
Reston, Virginia 22091
(703) 620-3660

HIGH EDUCATION
George Washington University
One Dupont Circle, Suite 630
Washington, DC 20036
(202) 966-2597

INFORMATION RESOURCES
Syracuse University
School of Education
Syracuse, New York 13210
(315) 472-3440

JUNIOR COLLEGES
University of California at Los Angeles
Powell Library, Room 96
Los Angeles, California 90024
(213) 825-3931

LANGUAGE AND LINGUISTICS
Center for Applied Linguistics
3520 Prospect St., N.W.
Washington, D.C. 20007
(202) 336-3592

READING AND COMMUNICATION SKILLS
National Council of Teachers of English
1111 Kenyon Road
Urbana, Illinois 61801
(217) 328-3870

RURAL EDUCATION AND SMALL SCHOOLS
New Mexico State University
Box 3AP
Las Cruces, New Mexico 88003
(505) 645-8283

SCIENCE, MATHEMATICS, AND ENVIRONMENTAL EDUCATION
The Ohio State University
1200 Chambers Road, Third Floor
Columbus, Ohio 43212
(614) 422-6717

SOCIAL STUDIES/SCIENCE EDUCATION
855 Broadway
Denver, Colorado 80202
(303) 931-0434

TEACHER EDUCATION
American Association of Colleges for Teacher Education
One Dupont Circle, NW, Suite 618
Washington, DC 20036
(202) 229-7280

TESTS, MEASUREMENT, AND EVALUATION
Educational Testing Services
Princeton, New Jersey 08541
(609) 921-5000 ext. 2176

URBAN EDUCATION
Box 40
Teachers College, Columbia University
525 W. 120th Street
New York, New York 10027
(212) 854-3417

Readers may wish to write to one or more clearinghouses to request a copy of that particular clearinghouse’s publications list or to be placed on the mailing list.

If readers are interested in submitting educational materials to the ERIC data base, they may send these materials to a specific clearinghouse if the materials fall within the clearinghouse’s scope of interest. It is also possible to send materials to the ERIC Processing and Reference Facility for distribution to the appropriate clearinghouse. The Facility’s address is

ERIC Processing and Reference Facility
4853 Rugby Avenue, Suite 303
Bethesda, MD 20014.
Information Services Available from ERIC/SMEAC

Listed below are services available from ERIC/SMEAC. You can request these materials or services by using the information request form found in this bulletin. Some services are free, others have a cost involved.

Free Services
1. The annual information bulletin
2. General information about ERIC or ERIC/SMEAC
3. ERIC/SMEAC publication lists
4. Information about ERIC microfiche collections in your state
5. Information about computer search services available in your state
6. Information about specific publications
7. Assistance in locating information on topics within our scope areas (science education, mathematics education, environmental education)

Services for Which There is a Charge
1. ERIC/SMEAC Publications
The SMEAC Information Reference Center currently has available over 100 publications related to science, mathematics, or environmental education. Included are teaching guides, instructional materials, directories, research reviews, collected papers, bibliographies, and other items. Costs vary from about $1.00 to about $20.00. Most items are under $6.00. Publication lists can be requested by using the request form.

2. Information Bulletins and Fact Sheets
Our Clearinghouse plans to produce four information bulletins in 1981. Each bulletin will be eight pages in length. A subscription for the four bulletins for 1981 is $3.00.
A list of back issues of information bulletins is available, also. Bulletins produced prior to 1981 are available for $1.00 per bulletin. Extra copies of the 1981 bulletins will be available for $1.00 each.

The Clearinghouse will also produce 12 fact sheets (four in each area: science, mathematics, environmental education) in 1981. Each fact sheet will be two pages in length. A subscription for the four fact sheets in one area is under $6.00. Publication lists can be requested by using the request form.

3. Scanned Computer Searches of the ERIC Data Base (RIE and/or CIJE)
Abstracts and other relevant information will be provided for requests at the current rate of $15.00 per 50 abstracts for the first 50 abstracts and $10.00 for every additional 50 abstracts thereafter. These searches are scanned for relevancy so that items not relating to the request can be removed. At the present time an average ERIC search costs $25-35. Searches of other data bases can also be done. Cost varies with the charges of the specific data base. Contact us for cost estimates.

4. Evaluative Comments Related to the Output of the Computer Search
Sometimes an ERIC user desires some evaluative information about the computer output. Questions such as "which are the better materials for our school?" "what are some of the better programs for our school?" or "which are some of the better research studies?" are frequently asked. Responses to questions can be provided at a cost of $10.00 per hour of staff time.

Our Clearinghouse has cooperated with The Ohio State University to produce compilations that provide abstracts, a descriptor index, an identifier index, an author index, and an institutional index for each of our areas of responsibility: science education, mathematics education, and environmental education. These publications are "bargains" compared to any computer searches and permit manual searches at a very rapid rate. Compilations for 1978-1980 are being produced. These publications are listed in the ERIC/SMEAC publication list and are priced from $15 to $22 each, depending upon the document.

6. Consulting Service
To provide additional help regarding selection of programs, materials, research studies, etc., we have available further assistance, if desired. Costs of such service will be negotiated prior to rendering the service.
ERIC/SMEAC INFORMATION REFERENCE CENTER
The Ohio State University
1200 Chambers Road, 3rd Flr.
Columbus, OH 43212

Information Request Form

NAME

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CITY          STATE          ZIP

Information Desired (Check all appropriate sections)

1. Mailing list request form and annual bulletin (free)
2. Publication lists (free)
3. Short Guide to ERIC and ERIC/SMEAC (free)
4. List of ERIC microfiche collections in my state (free)
5. List of computer search services in my state (free)
6. Listing of past Information Bulletins and Fact Sheets (free)
7. Computer Search Service
   If you desire to contract for search help, include your telephone number and best time of day to reach you by telephone. A staff member will call to discuss your search and to provide an estimate of the cost that would be involved. Please include a statement regarding the information desired so that the ERIC staff person in the appropriate content area can contact you.
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