Listed are journal articles and dissertations related to science and mathematics education for young children (mostly pre-school through primary grades). Each entry includes a short annotation indicating the contents and the type of article. The first section on science is divided into sub-sections dealing with: general topics (including behavior studies, general approaches, and international articles); science activities; concepts and concept development; conservation (as used in learning theory); curriculum design and discussion of curriculum projects; perceptual discrimination; objectives; descriptions and evaluation of head-start programs; equipment and materials; discussion of Montessori methods; studies of perception; work based on Piagetian theory; and studies of problem solving. The second section lists discussions and studies on the teaching and learning of mathematics. The third section lists relevant bibliographies. (EB)


SEIAC/SCIENCE EDUCATION INFORMATION ANALYSIS CENTER

... an information center to organize and disseminate information and materials on science education to teachers, administrators, supervisors, researchers, and the public. A joint project of The Ohio State University and the Educational Resources Information Center of USOE.
SCIENCE EDUCATION INFORMATION
REPORTS

SPECIAL BIBLIOGRAPHIES

BIBLIOGRAPHY 1

SCIENCE AND MATHEMATICS FOR YOUNG CHILDREN:
AN ANNOTATED BIBLIOGRAPHY
January, 1964 - June, 1969

By Francis Case Theiss
San Jose Unified School District
San Jose, California

ERIC Information Analysis Center
for Science Education
1460 West Lane Avenue
Columbus, Ohio 43210

September, 1969
The Science Education Information Reports are being developed to disseminate information concerning documents analyzed at the ERIC Center for Science Education. The Reports include five types of publications. General Bibliographies are being issued to announce most documents processed by the Center for Science Education. These bibliographies are categorized by topics and indicate the availability of the document and the major ideas included in the document. Special Bibliographies are being developed to announce availability of documents in selected interest areas. These bibliographies will list most significant documents that have been published in the interest area. Guides to Resource Literature for Science Teachers are bibliographies that identify references for the professional growth of teachers at all levels of science and mathematics teaching. This series will include six separate publications. Occasional Papers will be issued periodically to indicate implications of research for science and mathematics teaching. Research Reviews will be issued to analyze and synthesize research related to science and mathematics education over a period of several years.

The Science Education Information Reports will be announced in the SETAC Newsletter as they become available.
SPECIAL BIBLIOGRAPHIES - SCIENCE

Special Bibliographies are being developed to announce availability of documents in selected interest areas. These bibliographies indicate documents considered to be useful to teachers, curriculum development personnel, and research personnel. They are aimed primarily, however, at teachers and curriculum personnel.

The bibliographies are developed in areas of demand as indicated by communications received at the ERIC Center for Science Education. We invite your suggestions for areas to be included in this series.

Robert W. Howe
and
Stanley L. Helgeson
Editors
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SCIENCE AND MATHEMATICS FOR YOUNG CHILDREN
AN ANNOTATED BIBLIOGRAPHY

I. SCIENCE

A. General Topics

Achievement


One finding: socio-economic background was not a predictor of success when non-verbal behavior was required.

Articulation


Discusses an articulated type of nursery-kindergarten program. Many suggested activities include science experiences.

Behavior


Task consisted of 3-step game which involved building with tinker toys, color and form matching, and choice of reward box. One implication of study: children will imitate other children of same age and sex in an experimental setting.


Data showed that children did better when stimuli of a concrete nature were presented rather than verbal stimuli by themselves.


Purpose of study: to design a technique for collecting, scoring and evaluating scientific aspects of curiosity as expressed behaviorally by first grade children.

Bibliography.

Bereiter


**Classification**


Describes experiments with four-year-olds to explore certain parallels in the children's ability to order and orient objects.


An investigation of 4-6 year old children's understanding of the logic of classes and number. They could not understand the relation between classes and sub-classes.


Findings of this study support construction of a specialized curriculum for the teaching of classification abilities to children from low socio-economic backgrounds.

**Dainton Report**


A summary of the recommendations of the Dainton Report on science education in Britain is followed by two articles appraising the report and its impact on British schools.


An analysis of the Dainton proposals and a listing of its recommendations.

**Discovery Method**

States that content comes from all areas of science. Skills of observation and development of the use of the senses are stressed. Discovery is emphasized.

A detailed discussion of the methodology of teaching by the discovery method.

Form Recognition

The finding of this study that young nursery school children are more likely to recognize a form if they manipulate it than if they merely inspect it visually is in general agreement with the literature.

Government in Education


Intellectual Skills

Purpose of Study: (1) to construct lessons in science designed to teach selected skills; (2) to develop group non-reading tests which would measure the growth of the intellectual skills of observation, classification, data treatment and measurement.

Interdisciplinary Approach

Discusses methodology of discovery approach to science teaching. States that preschool science should be taught as an interrelated field and as an integrated part of child's school day.

Round-table discussion includes interdisciplinary programs for young children.
Kennedy Preschool Program


Analysis of Number Readiness variable shown to be significant in favor of Kennedy group.  Study indicated positive relationship between length of preschool attendance and readiness for first grade.

Nurturance


Hypothesis I, that nurturance would lead to more persistence, was not supported; hypothesis II, that nurturance would lead to increased effectiveness, was partially supported.

Oxford Primary Science Project


Describes the establishment and purposes of a research project at the Oxford University Institute of Education to inquire into the formation of scientific concepts in young children.

Note: In British education, the term "young children" refers to the age group 5-13, which group attends "primary" schools; the hierarchy being: Infant schools, Junior schools and Primary schools.

Plowden Report


Includes a complete detailed listing of all of the proposals of this report, which concerns the reform of nursery and primary education in Britain.


An editorial appraising the recommendations of the Plowden Report on primary education in Britain.

Probability Judgements


Two samples made probability judgements under two conditions: Piaget procedure and decision-making procedure.  Results analyzed.
Readiness

States that experiences in science, in situations conducive to vocalizing, contribute toward making children language-ready for reading.

Science—Australia

Discusses methods proposed by the Victorian Primary School Science Committee.

Discusses the "Process Approach" as a means of teaching primary science.

Science—Handicapped

Discusses the Aoupedic Method of "auditory bombardment" for preschool education of hard-of-hearing. Suggests activities.

A special issue devoted to "Curriculum: Content and Cognition: Curriculum for the Deaf." Organized by curriculum area.
See BIBLIOGRAPHY for contents of curriculum areas Natural Science and Mathematics.

Science—Pakistan

The scope and sequence of primary science was evaluated on the basis of developed criteria. One conclusion: primary science is structured ahead of time but not enough opportunity is provided for flexibility.

Science—USSR

Outlines proposed natural science curriculum for G1, 2, 3. Emphasizes "those methods which are peculiar to the sciences of nature" being used during the study of nature.

"Teach the child to seek the answers to his questions in books and in science." Recommends greater amount of "scientific and geographic" knowledge be presented.

Sex Education

Discusses a classroom incubation experiment to teach the concept that all living things come from other living things and eventually die.

Sex education should begin very early and be dealt with knowledgeably. Suggests activities for understanding of reproduction.

Skills

Results indicated that both instruction and practice treatments produced significant gains in puzzle-assembly skill.

Study and Teaching

Discusses growth and development, metabolism, reproduction, responsiveness, community, adaptation, change. A concise treatment, geared to those with little science background.

Transfer of Learning

Conclusion: prior training in one sense modality did not affect learning-set formation in a second sense modality.
Mumbauer, Corinne C. and Richard D. Odum. "Variables Affecting the Performance of Preschool Children in Intradimensional, Reversal and Extradimensional Shifts." Journal of Experimental Psychology 75:180-7. 1967. Abstract: PA41:06499. 144 preschool children were presented a transfer-of-discrimination task in which the variables were overt verbalizing, overtraining, dimension and shift. Dimension was found to interact with each of the other variables in determining transfer performance.

TV Instruction


B. Activities


Note: "Early Education Guide" is a regular monthly feature of Grade Teacher.

Have children bring acorns, etc., to school and discuss them.


A pupil dramatization culminates a six-week G1 unit on toys involving experiences with five forces related to air, muscles, electricity, gravity and magnetism.


Describes activities using musical chairs, dolls and carriages and play-dough.


Discusses concepts and activities centered around outdoor observation of fall fruit. Includes supplemental activities in art, social studies, math and language arts.


Includes seven tested activities.


Describes a four-week summer animal study project for children of low socio-economic backgrounds.


Describes a candle-making activity as a natural way of introducing young children to some of the many changes which matter can undergo.


Describes a plan for creating individualized science lab lessons for K-3 non-readers.


Procedures consisted of reviewing the literature related to the topic, identifying learning factors in problem solving and concept development, identifying science concepts appropriate for primary grades, and designing sample experiences.
An outline of calendar-oriented Kindergarten science activities from October-June.

Includes materials list, safety rules, activities, bibliography.

Describes a lesson which is part of a unit on "Investigating Systems."

Nine Froebel-devised activities were used. A comparison made between theoretical justifications given by Kindergarten educators and the purposes given by Kindergarten teachers revealed discrepancies between theory and practice for five of the activities.

Describes baby chicks hatching from their eggs in a K classroom.

C. Concepts

Nonverbal evaluation techniques can be used to assist in the grade placement of science concepts at the primary grade level.

Evidence indicates that it is possible to create an objective, teacher-administrated, non-reading, group science mastery test. Illustrated.

Describes practical experiences to help primary children form concepts of area.

Purpose of study: to assess number knowledge of preschool children and to determine which factors influence the early growth of number ideas.
Biblio.


Freeman, Valdora Y. "Relational Concepts." Instructor 77:28+. April, 1968. Survey showed that children need a working knowledge of relational terms if they are to respond correctly to directions and materials of all kinds.

Fromberg, Doris Cronin. The Reactions of Kindergarten Children to Intellectual Challenge. Dissertation: Columbia, 1965. DA 26:904. Focus of this study is upon children who were exposed to science experiences that were meant to concretize aspects of the concept of the interaction of forces in the physical world.


Lepper, Robert Earl. A Cross Cultural Investigation of the Relationships Between the Development of Selected Science-Related Concepts and Social Status and Reading Readiness of Negro and White First Graders. Dissertation: Florida State, 1965. DA 26:4501. Piagetian tests used in this study are tasks of conservation of continuous substance, discontinuous substance, number, length and area. Only significant difference found between the three levels of social status was on the task of conservation of continuous substance. Also in Journal of Research in Science Teaching 5(4):324.


Data were secured by personal interviews with 140 beginning first grade children.  Responses to the interview questions were recorded by check-marks or brief sentences on checksheets prepared for each child.


Evidence favoring the conceptual sequence: "momentum → conservation of matter → proportional use of mass and velocity → velocity" is presented.

Bibliography.  See DA 26:3762.


Results agreed with Piaget's findings on the development of the conservation of matter, speed and the proportion schema.


A series of anecdotes dealing with young children and their emerging scientific concepts.


Discusses a study to determine whether a process of stimulus reorganization or simple rote memory was more basic for learning in young children.

Biblio.


One conclusion:  the preschool child is capable of organizing facts into principles, principles into generalizations, and generalizations into coherent concepts.


Student teachers interview a sample of K-2 children to gather data on early levels of perception and scientific reasoning.


Describes a study to determine the capacity of children of kindergarten age of varying abilities to develop mathematical concepts related to telling time.
Describes how experiences with classroom animals can teach primary-level concepts relating to life and death.

D. Conservation*

In line with Piaget's analysis of concrete operations the results of a test of 30 K-G3 children suggested a shift in orientation toward the problems occurring during G1 and G2.

Deals with the ability of preschool children to use the relational terms "more", "same" and "less" when comparing the number, length and weight of objects.

Describes a study designed to test the hypothesis that selected experiences would enhance the ability of K children to conserve numerousness. Extensive (38-entry) bibliography.

Describes and evaluates a test of conservation of numerousness administered to 341 children at the end of the first grade. Bibliography.

Purpose of the study: to investigate whether certain sets, experimentally induced, could determine responses to conflict trials and to tests of conservation.

E. Curriculum


*Those interested in Conservation should also check Piaget heading.
Describes the development of an evaluative instrument to be used by curriculum researchers to measure and compare attainment of the goals of K-3 science curriculums.

Includes a discussion of the role of the science curriculum in the full-day schedule.

"The need to teach concepts related to the regularities of time is fairly obvious—less obvious, however, is the need for specialized approaches which involve presenting these concepts to the lower class child in meaningful ways." Suggests activities.

"A premature emphasis on the teaching of traditional academic skills at the pre-school level is inconsistent with the necessity to foster each child's creative potential."

The experimental program proved to be significantly more effective in promoting intellectual functioning, language abilities, perceptual development and school readiness.

Describes a two-year preschool program for disadvantaged children. Children in program experienced average IQ rise of 14.6 points over the two-year period compared to an average gain of 4.0 points in the control group.

Includes the processes in the AAs program for the primary grades.

Describes the designing of a program, based on the reactions to the proposed materials of a group of first graders.

A comparative chart including projects for Kindergarten.


A chart listing ten projects. Information includes project title and director, address, purpose and grade level, present accomplishments, project evaluation, future plans, commercial affiliations, materials for purchase and free materials.


Describes a test of the Bereiter-Engelmann program in a Head Start setting. Results indicated that long-term exposure to B-E curriculum raised IQ's and stimulated development in reasoning ability. Bibliography.


Includes earth-space concepts for primary level and a suggested approach to sequential science learning.


The bulk of this article is concerned with curricular development at the K-Primary level.


Includes a discussion of the science curriculum's emphasis on care, observation and function, rather than on structure.


Includes guidelines for the development of a science curriculum.

F. Discrimination


Forty 3-4-year-old children were given cross-modal transfer problems involving presentation of identical form discriminations in the visual and tactual modalities. Transfer, without relevant verbalization, was obtained from vision to touch, but not from touch to vision.

Results of this study indicated a significant deficiency in auditory discrimination among the economically disadvantaged group.


Identical tests were given to groups of nursery school and 7-9-year-old children. The preschoolers gave more color responses under all conditions than did the 7-9 group.


Differences in hue had no significant effect on color matching at K level, while differences in brightness produced the greatest number of color matches.


Purpose: to develop a test designed to measure tactile discrimination in young children and to examine it in relation to age and sex. One result: the only observed significant difference between boys and girls was found in the age range of 6:2-6:8, the girls obtaining higher scores at this age than the boys.


A test of preschool children showed that young children exhibit a deficiency in mediation under some conditions (perceptual set) but not others (learning set). Bibliography.


Four-year-old nursery children were used to study the relation between discrimination and preference. Differences were significant in the relational discrimination scores for high and low preferrers.

G. Goals


Includes a discussion of science- and math-oriented goals.


Discussion of values and goals of preschool education includes introduction of scientific concepts.

Includes a section on science teaching which discusses the experimental approach and the shift in emphasis from product to process.


"The science program for young children should deal with concepts that are consistent with their intellectual development. The emphasis should be on phenomena that may be observed and manipulated." A thoughtful and perceptive treatment of the subject.


A thorough treatment of goals for science education for young children.


H. Headstart


Discusses the value of a science program for deprived young children. States that variety and balance, coupled with flexibility, are key values for well thought-out science curriculum for young child.


Discusses activities related to measurement concepts.


Achievement assessed and compared for the three groups on five variables: articulation, auditory discrimination, visual discrimination, recognition vocabulary and conceptual maturity.


Discussion of the relative merits of various types of equipment and materials.
Muse, Vernon Clyde, Ed.D. An Assessment of "Headstart" Training on Intelligence and Achievement of a Selected Group of First Grade Students. Dissertation: Mississippi State University, 1968. DA 29-6:1724 A.

No statistically significant differences shown between test and control groups.


An evaluation in which teacher comments support the effectiveness of the program. K and G1 teachers report that younger siblings of pre-Headstart children, who have attended Headstart schools, show improved behavior and readiness compared to their older brothers and sisters.


An extensive listing of materials for specific Headstart activities.


No significant differences in performance or gains between the samples on readiness tests or teacher ratings. Kindergarten teachers noted more improvement than indicated on tests.


Includes guidelines for developing science and math concepts.

I. Materials


"If we aim at encouraging a child to discover for himself his own and the world's boundaries and possibilities, the physical structure of a school must be of a kind which will aid self-knowledge and independent inquiry."


A comprehensive listing of materials, arranged by such subject areas as Science (22 items), Building Blocks, Wheel Toys.

Note: This article is one of a group of several articles in this issue under the heading, Special Report: How Preprimary Programs Work (pp. 48-68+).


Covers materials needed, procedure and what to collect.
Discusses kindergarten activities with food choppers.

This study attempts to evaluate the success of curriculum materials through personal interviews similar to those employed by Piaget.

Process of preschool "education with purpose" involves a variety of materials to provide "ventures into the unknown." Should seek awareness of "the beginning of things."

J. Montessori

Montessori and Piaget should be accepted on their own terms and their ideas not forced into current conceptual frameworks.

Discusses adaptation of Montessori methods to current situations.
Includes suggested activities for sense development. Biblio.

Discusses incorporation of her ideas in modern practice without following the strict, orthodox methodology.

This concise evaluation includes a discussion of the Bereiter plan.

Two articles—one favoring and one critical of Montessori methods.
Includes examination of approach to experimentation and investigation.

This article includes over four pages of "notes" which comprise an excellent bibliography of the literature of the Montessori Method.
K. Perception


Hypothesis was confirmed that amount of color and complexity of certain stimuli would be related to level of color response.


Results of testing showed that beginning with age 5, preschool children are able to perceive proportions of figures as a special property of figures.


Reports a follow-up study of achievement in G-1 after training with the Frostic Program for Development of Visual Perception in Kindergarten.


L. Piaget


A longitudinal study examining the question: "Does the ability to carry out operations of class and seriation as they relate to number concepts develop according to a pattern which could be described as synchronous or sequential?"


Behavior and explanation conservation items given to sample of 143 K, G1 and G2 children. Two scales constructed from these items. Scales cross-validated on new sample. Significant correlations with school grades and other variables found.


It was noted that the demarkation between size and weight in the last years of the preoperational period and those in the early years of concrete operations was clear, and corresponds with Piaget's accounts.

Piaget and Montessori should be accepted on their own terms and their ideas not forced into current conceptual frameworks.


Subjects were pupils of seven Nigerian primary schools. Results generally upheld Piaget's theory.


A conceptual framework for a preschool curriculum is indicated, that is particularly geared to the needs of disadvantaged children leading to the development of logical thinking and creativity.


Reviews the implications of the cognitive-developmental theories of Baldwin, Dewey, Piaget and Vygotsky for preschool children. Thesis: cognitive-developmental components of preschool play and other activities should be systematically formulated.


Eleven procedural tasks were given to 96 children from 4 age levels: 4, 5, 6 and 7. Responses consisted of a judgement and an explanation of the reasoning which led to that judgement. Results are discussed in terms of their relevance to previous experimental findings and theoretical formulations of Piaget and other investigators.


Findings support Piaget's hypothesis of sequential stages in both cognitive and moral judgement; also, his thesis of concomitant growth of the two modes of thought.

This study of Negro and white first graders reveals that the development of Piagetian conservation concepts reflects differences in cultural background rather than in race.


A scholarly discussion of Piaget's theory of cognitive development.


Discusses the possibility of accelerating a child's development through instruction which places the child in situations which produce a resolvable cognitive conflict.


"If acceleration of development is possible, we can profitably expose the child to more mathematics than is presently incorporated in the elementary school program." Bibliography.


Idea of conservation of matter (referring to concept of sameness) was chosen for acceleration through training. Results showed changes in performance for transitional children but no significant changes for nonconserving children.


Poems and verses from five selected anthologies plus 17 original verses were analyzed.


Discusses the development of the child's intelligence using a step-by-step approach which facilitated the transition from sensory-motor to conceptual intelligence. Bibliography.

Purpose of the study: to determine whether a relationship exists between developmental age and the ability to internalize and reproduce three-dimensional forms in two dimensions.

M. Problem Solving


Levin, Gerald R. and Deborah R. Hamermesh. "Procedure and Instructions in Kindergarteners' Matching-to-Sample." Psychonomic Science 8:429-30. 1967. An observing response procedure and instructions designed to induce a problem-solving set were studied in 48 Kindergarteners presented with matching sample-to-sample problems. The antecedent variables were found to facilitate performance.


II. MATHEMATICS

Ashlock, Robert B. "Planning Mathematics Instruction for Four- and Five-Year-Olds." Arithmetic Teacher 13:397-400. May, 1966. Identifies and discusses the basic concepts to be developed at this level and selection of appropriate activities. Bibliography.

Purpose of study: to develop a test of understandings of selected properties of number systems suitable for use with G1 and 2. Bibliography.


A description of some of the mathematical understandings which may be developed with young children.


A test of pupil understanding of basic properties of a number system was developed and administered to G1 and G2 children. It was found to have a high degree of reliability and validity, as well as suitability for the primary grades.


Suggests interesting, practical and effective ways of presenting a mathematics program to children of kindergarten age.


Reports a series of studies in which 50 Kindergarten children were given systematic tutoring in number concepts in the preschool age.


Purpose of study: to assess number knowledge of preschool children and to determine which factors influence the early growth of number ideas. Bibliography.


Provides evidence that the order in which parts of a form are scanned changes in the preschool period.


Discusses the need for formal planning of young children's math experiences.

Presents the rationale for and the content of a mathematics program written for and taught to a group of Mexican-American disadvantaged first-graders. Bibliography.


Study reveals that nursery and Kindergarten teachers have been giving math concepts to children but may not have been aware of what they were doing.


One recommendation: provision should be made for adequate pre-service and in-service training for teachers.


Includes preschool and kindergarten activities in science and number readiness. 

Note: "Early Education Guide" is a regular monthly feature in Grade Teacher.


"The following series of card games is offered almost as a curriculum in beginning mathematics. It presupposes only that the youngsters have all learned to recite the counting numbers up through ten."


Describes activities to teach shape discrimination and properties of shapes.


Describes activities with block-, bar- and picture-graphs.


Describes games with finger puppets, listening for coins in a box and spinner games.

Some conclusions: Kindergarten children have ability to rote count far beyond ten; K males and females did equally well on six of the eight subtests.


One conclusion: pupils taught by the C-G method acquire mathematical concepts and skills that were not taught in the traditional program.


Using the difference between pre- and post-test scores as criteria, the results suggest that all the children learned the required skills.


Describes three lessons: The Use of Records, Making a Record of Groups of Things and Developing an Understanding of Two-Place Numerals.


Results of this study indicate that the preschool child possesses quantitative ability to a degree which needs the attention of curriculum makers and teachers.


Purpose of study: to determine the understanding of specific number concepts of preschool children and to attempt to determine mathematical areas that need emphasis in the Head Start Curriculum.


Describes children's use of materials during problem solving in the area of measurement.


"It is now the specialists in the respective fields of science who have undertaken to revise the content of school education and are taking a direct part in compiling new curriculums."


Swartz, Evelyn. "Interrelationships Between Mathematics and Art for the Kindergarten." Arithmetic Teacher 15:420-1. May, 1968. Discusses activities correlated to the fact that both math and art are concerned with the objective of helping children develop visual perception skills so they can recognize and identify shapes, sizes and colors.

Piaget-type number concept test given to sample of entering G1 children. Some conclusions: conservation of number seems to be more highly related to achievement than counting or cardination; wide variance of understanding of Piaget-type number concepts.


One purpose of study: to discover some of the home influences affecting math achievement at Kindergarten level.


One finding: children respond more successfully to items concerning measurement, number, geometry and logic than to other mathematical strands.


Discusses the preschool development of the concept of various relationships, such as "more than," "less than," "the same as" and one to one.

III. BIBLIOGRAPHY


Special issue devoted to "Mathematics Through Media."


A special issue devoted to early childhood education.

Children 16(2). March/April, 1969.

Features a special section: "Children Under Three—Finding Ways to Stimulate Development."


Organized into 15 general categories, prices are quoted, items are graded and list of suppliers with addresses is included.


Features "A Beginner's Basic List of Audio-Visual Resources in Early Childhood Education." Includes addresses of distributors.

A general annotated listing of periodical and pamphlet references covering the period 1963-4 and including many science-oriented entries.

Includes an extensive listing (c80 entries) of "Selected Research References" in problem solving.


Volta Review 70. September, 1968. (Published by the Alexander Graham Bell Assoc. for the Deaf.)

This article includes over four pages of "notes" which comprise an excellent bibliography of the literature on the Montessori Method.

Lists eight criteria for book selection and includes bibliography of review sources.