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ABSTRACT

The Science Curriculum and Assessment Project is a multi-state network of school districts and other educational agencies that actively promotes science improvement through the alignment of curriculum, instruction, and assessment. This document describes the major areas of project work, specifications and review procedures for test items in the project's item collection, available products, and membership benefits. Appendices include: (1) an inventory of test items by goal and grade level; (2) a list of science concepts and processes; (3) criteria for eliminating ethnic, racial, gender, and sex role bias from tests; (4) pointers on how to write good test items; (5) a list of the characteristics of a high-quality multiple choice test item; and (6) membership forms. (CW)

Northwest Evaluation Association

SCIENCE CURRICULUM AND ASSESSMENT PROJECT

DEVELOPING QUALITY SCIENCE PROGRAMS

A Staff Development Project
for
the Improvement of

- Curriculum
- Instruction
- Assessment

Prepared for AERA Symposium
Evaluation of Process Science Skills
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TABLE OF CONTENTS

WHAT IS THE SCIENCE CURRICULUM AND ASSESSMENT PROJECT?

The project is a multi-state network of school districts and other education agencies that actively promotes science program improvement through the alignment of curriculum, instruction and assessment. It was formed in 1982 by members of the Northwest Evaluation Association in response to the obvious need for better assessment tools in science.

The project is probably best known for its quality workshops and its science test item collection. An annual **Winter Science Institute** provides staff development training to administrators and teachers in databased program improvement, curriculum development, instructional strategies related to science concepts and processes, program evaluation and assessment procedures, and the management of change. The **science test item collection** currently contains over 8,000 items covering a wide range of science topics as well as major concepts and processes that cross science disciplines. (See appendix A for an inventory of items by goal category). Each year, new items are written for selected grade levels and goal areas to broaden the coverage of the test items. The project's long-range goal related to the collection is to provide districts with a resource that will enable them to adequately assess all science areas in all grade levels.

Support for project activities comes primarily from an annual membership fee paid by participating agencies. Steering committee members include classroom teachers, school district curriculum and evaluation specialists, principals, university professors, and specialists from the Oregon Department of Education and Northwest Regional Educational Laboratory.

WHAT ARE THE PROJECT'S MAJOR AREAS OF WORK?

Each year the project develops a schedule of work designed to support local program improvement efforts. Over the past five years, ongoing work has included the development of materials, procedures and staff development activities in the following areas:

- *Improving science programs through the alignment of curriculum, instruction and assessment. This includes materials and procedures for helping school districts:*

  --Design a K-12 science program
  --Evaluate and select instructional materials
  --Identify goals to be assessed and develop evaluation designs
  --Develop curriculum-aligned assessment instruments useful for classroom and program evaluation purposes

- *Developing science test items for purposes of program and student assessment in the following areas:*

  --Science Concepts and Processes
  --General Science (K-10)
  --Biology
  --Chemistry
  --Physics
  --Earth/Space Sciences

The science test item collection will enable districts to develop a valid and reliable testing program, aligned to local curriculum. The current collection contains items covering grades K-12. All items are referenced to a comprehensive science taxonomy.

Within the next ten months, the collection will be divided into six separate item banks. Through extensive field testing over the next several years, all of the test items will be calibrated (i.e., a difficulty level for each item will be determined in relation to all other items in the bank. **The electronic version of the test items will be available in the fall of 1988.**

- *Increasing teacher understanding of the key concepts and processes that cross science disciplines. This includes assistance with clarifying concepts and processes, developing instructional objectives desirable or concept and process learning, selecting appropriate test items, and developing instructional methodologies, learning activities and materials.*

- *Providing staff development activities to increase the skills of teachers and administrators in the areas of data-based program improvement, curriculum review and planning, assessment, and the management of change.*

- *Promoting and supporting the development of cooperative working agreements among school districts, colleges and universities, regional educational laboratories, and state departments of education.*

WHAT ARE THE SPECIFICATIONS AND REVIEW PROCEDURES FOR TEST ITEMS IN THE ITEM COLLECTION?

Introduction to the Collection

For the past five years, the project has placed a strong emphasis on item writing activities in order to create a pool of well-constructed test items that assess student learning of science subject-matter goals and science concepts and processes.

The current item collection contains 8,000 test items in card stock form. Approximately 2,000 new items are added to the collection each year. An estimated 16,000 items will be needed to adequately assess science subject-matter goals, concepts and processes in all courses and grade levels.

The majority of the items currently in the collection were written by teachers who receive ongoing instruction in the techniques of writing high-quality multiple-choice test items. The remainder of the items are public domain items which have been revised to conform to NWEA specifications. Regardless of the source, the items currently in the collection are judged to be ready for field testing.

Items that survive field testing will comprise the intial NWEA Science Test Item Collection. Through subsequent field testing, the calibration (difficulty level) of each item will be determined using item-response theory (IRA) methods. Initial research field testing indicates that all of the items cannot be calibrated using a single, underlying scale. The following six scales have been identified to date:

- Concept and Process Items
- General Science (K-8)
- Biology
- Chemistry
- Physics
- Earth/Space Sciences

The items are being divided into separate banks corresponding to the six scales listed above. Once this transition has been completed, the banks will be available only in electronic form. The card stock versions will no longer be produced. It is anticipated that the electronic form of the six collections will be available in the fall of 1988.

The Item Collection

The purpose of this section is to describe the criteria and specifications used by the Science Curriculum and Assessment Project in the development of the item collection. One of the major innovations of the project is the inclusion of items for both (1) conventional subject-matter topics and (2) the concepts and processes of science.

Science Topics

The item collection contains items related to the following science topics:(*)

A. Life Sciences
- The Cell
- Zoology
- Botany
- Simple Life Forms/Diseases/Functions
- Ecology

B. Earth/Space Science
- Geology
- Oceanography
- Meteorology
- Space and Astronomy

C. Physical Sciences
- Measurement
- Matter: Properties/States/Changes/Structure
- Periodic Law/Table
- Acids, Bases, and Salts
- Chemical Kinetics/Equilibrium
- Oxidation-Reduction
- Electrochemistry
- Organic Chemistry
- Nuclear Chemistry
- Photochemistry/Spectroscopy
- Chemistry and Society
- Biochemistry
- Motion
- Gravity
- Electricity and Magnetism
- Energy/Transformations/Energy Resources
- Light
- Modern Physics

D. History of Science

E. Careers in Science

F. Laboratory

G. Vocabulary

(*) The NWEA Science Item Collection Index provides a complete listing of the subcategories contained within each major topic.

Science Concepts and Processes

In addition to the conventional topical categories of science instruction, the project focuses on major concepts and processes of science learning. With the inclusion of concept and process items in the collection, it is possible to design sophisticated science achievement tests that assess both subject-matter knowledge and higher-level thinking skills. Given that science knowledge continues to accumulate and change at a rapid rate, the objectives of teaching conceptual and methodological understanding of science will require matching assessment methods. The item collection's concept and process items make possible the design of such tests.

The collection contains items related to the following science concepts and processes:

H. Concepts

- Cause-Effect
- Change
- Cycle
- Energy-Matter
- Entropy
- Equilibrium
- Evolution
- Field
- Force
- Fundamental Entities
- Gradient
- Interaction
- Invariance
- Model
- Order
- Organism
- Perception
- Probability
- Population
- Quantification
- Replication
- Resonance
- Scale
- Significance
- Symmetry
- System
- Theory
- Time-Space
- Validation

I. Processes

- Classifying
- Communicating
- Controlling Variables
- Defining Operationally
- Designing Experiments
- Formulating Models
- Hypothesizing
- Inferring
- Interpreting Data
- Measuring
- Observing
- Predicting
- Questioning
- Using Numbers
- Relating Time-Space

A brief definition of each concept and process is provided in Appendix B.

Item Specifications

To develop a high quality test item bank, the project relies on the cooperation of many educators. Curriculum experts and teachers periodically review the items in the collection. Through review, careful editing and field testing, flaws and ambiguities are removed from items that enter the collection. The project's recommended procedures for reviewing items will be described subsequently. The procedures are based on actual experience with the challenges and rewards of reviewing thousands of test items.

The project's item development and review process is shown in Figure 1. Here are some points to note in looking at the flowchart:

- Items enter the item collection from three main sources:
  1. Annual writing workshops conducted by the project,
  2. Local district production of new items, and
  3. Other item collections or catalogs obtained from educational agencies and research centers.
- Items receive peer review either at the workshops on item writing or from the project editorial board.
- Flawed items may be identified by workshop participants, users of the collection, the editorial board, or on the basis of field test statistical results.

Item Development and Review Process

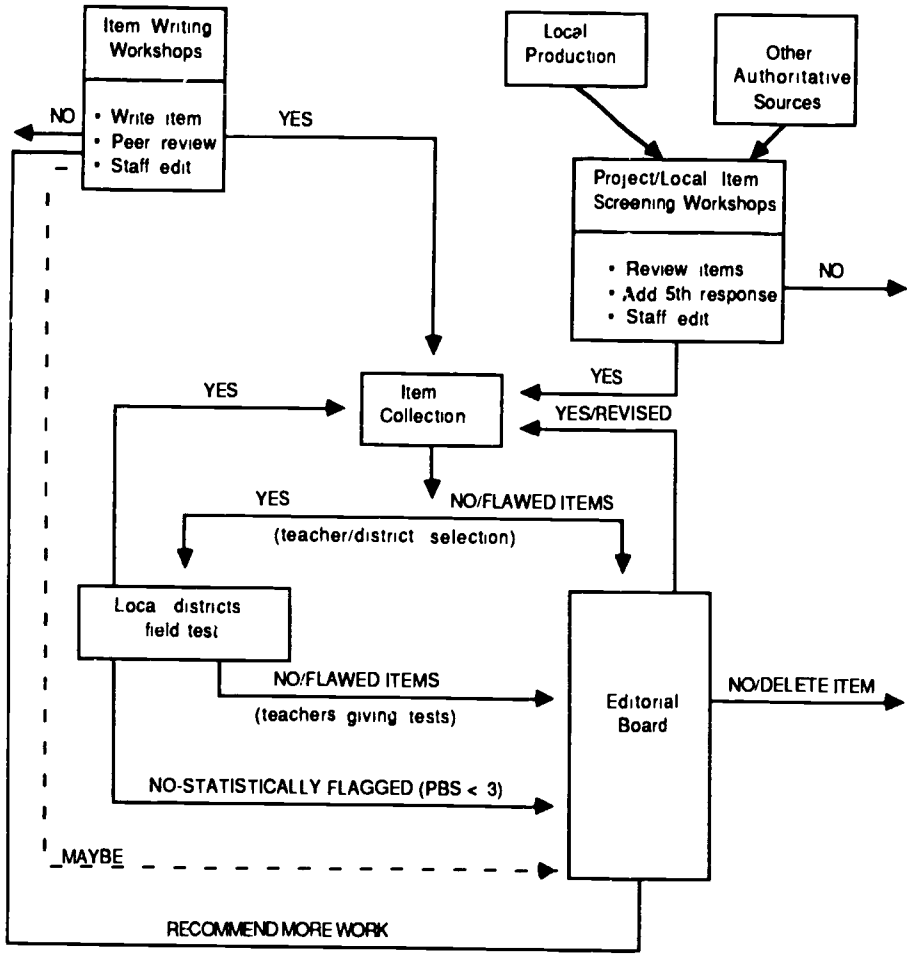

Figure 1

Steps in the Item Development and Review Process

The first step in adding items to the collection is the determination by project staff or local project members that (1) items must be written to fill identified gaps, or (2) existing items can be modified from authoritative sources (e.g., the National Assessment of Educational Progress). The process of item generation and review for each of these two options can be summarized as follows:

I. New Items: Steps

1. Item writing workshops or local production
2. Apply criteria for item writing

II. Existing Items: Steps

1. Item screening workshops or local screening
2. Add 5th response if needed

All Items

3. Peer review at workshops or in local settings
4. Code items to the appropriate goal categories
5. Assign a grade level range (K-3, 4-6, 7-9, 10-12) to each item
6. Apply criteria for elimination of racial or gender bias
7. Enter acceptable items into the collection
8. Flawed items are sent to the editorial board and revised or discarded
9. Field testing
10. Statistically flagged items are sent to editorial board

Writing New Items

Each year the project conducts item writing sessions for project members and other interested educators. These sessions are designed to: (1) introduce participants to the writing of concept and process items, and (2) train participants in the principles of writing good multiple-choice test items. Two major principles of good item writing are used as guidelines:

1. To keep each item free from "test-wiseness" factors that allow students to derive the answer by guessing or test-taking skills unrelated to science achievement. Examples are implausible wrong answers, cues or hints to the answer, the correct answer being the longest alternative in a multiple-choice format, etc.

2. To make sure that the item is "science-achievement pure." By "science achievement" we mean the facts, concepts, principles, and skills that are the intent of the science curriculum being assessed. By "pure" we mean that the item does not simultaneously measure knowledge in science and extra

skills such as reading ability (as in the case of items that are too wordy), logical-thinking (where the answer is derivable by an attentive, logical person who may know nothing of the science objective being tested), general intelligence, or ethnic/cultural knowlege.

In other words, good items are those that directly and exclusively test the targeted science fact, concept, principle, knowledge, skill, or sensitivity without the interference of guessing, test-wiseness, reading ability, or other skills or factors unrelated to science achievement.

There are a number of lists of "item writing rules" in the literature on educational testing. Below is a suggested list for implementing the two major principles of item writing.

Criteria for NWEA Multiple-Choice Items

1. Freedom from racial, ethnic or sex-role bias or stereotyping. (See Appendix C: Criteria.)
2. Clear, appropriate, simplest possible text, with terms used accurately.
3. One right or best answer, with plausible distractors. If the "best" answer is requested, criteria for choice of "best" is given.
4. No give-aways: answer choices about the same length, no grammatical cues, etc.
5. All information needed to choose the correct answer is given except that for which the item tests. In other words, students who have command of that process or concept or information tested can get the item correct, whether or not they have related background information that is commonly expected.
6. Language used in the item is standard usage, spelled and punctuated correctly and appropriate to grade level and subject.
7. Graphs or illustrations are clear and accurate.
8. Item is logically content valid. That is, it measures the goal to which it is related. (If students get the item right, they probably do have the knowledge or skill described by the goal; if they get the item wrong, they probably don't.)
9. Correct answer is keyed.
10. All items have five alternatives (correct answer plus four distractors).

In addition to these criteria, workshop participants are given a set of recommended steps in item writing (See Appendix D: Writing Good Test Items -- How?).

Screening Existing Items

The project screens items obtained from existing sources such as other item banks or catalogs. Workshops and a training manual are used to prepare teachers to review and screen promising items identified by project staff. Screeners use the Criteria for NWEA Multiple-Choice Items to judge the suitability of the items. Appendix E provides a list of additional characteristics examined when item screening takes place. Also, to provide uniformity in the item collection, and to reduce any ptotential guessing factors, the number of item alternatives (correct answer plus distractors) is set at five. If existing items only have four alternatives, a fifth is added by the screening team. Each item is coded to one goal category and a grade level estimate is given using the levels K-3, 4-6, 7-9, and 10-12. Item screeners are selected if they have both knowledge of the topical area and familiarity with teaching at the grade level of the items to be screened. On the initial pass, all items are screened by at least two people.

Functions of the Editorial Board

The project's editorial board meets on a monthly basis to review items that have posed difficulites for users of the collection or field test participants, or items that have been flagged in field testing. The role of the board is to attempt a judicious review and to resolve ambiguities, not to do extensive revisions of items. The board is guided by the following options for routing reviewed items:

1. Revise the item and send it back into the collection.

2. Reject any items that either will take too much time to revise or are unrecoverable.

The board is further guided by the principle that it takes a lot more time to repair an item than to find a new (good) item.

Field Testing of Items

All items in the collection will eventually be field tested on samples of 200 or more students and calibrated using item response theory or Rasch model methodologies. In addition to this long range goal by the project, local districts and project members are encouraged to conduct conventional item analyses on any tests constructed from the item collection. Where samples of 150 or more students are included in field testing, the project requests a computer tape or diskette containing the item response data. In addition, all field testing uses of items in the collection are encouraged to include computer analyses of item characteristics such as discrimination (correlation between the item and the total test score). A criterion of correlations lower than .30 has been set by the project to help identify potentially flawed items.

In addition to statistical analysis of items, field testers are encouraged to send project staff any comments from teachers or students that may have been noted during a field test tryout of items Any potential ambiguities, typographical errors, or other flaws may be indentified in this way.

Additional Checks

To maintain the quality of the item collection and to direct future searches, two record forms have been developed: The Flawed Item Form and the Content Reaction Form.

Flawed Item Form. During the process of reviewing items, or after administering a test, items may be discovered that are flawed in some way (e.g., incorrect key, incorrect goal information, or incorrect information in the item). These flaws are noted on a Flawed Item Form. A separate form is completed for each flawed item. These forms are then reviewed by the editorial board.

Completion of the Flawed Item Form is an important step in the development of the NWEA Science Test Item Collection. It is one more way to detect flawed or weak items in addition to those detected by the item review panel and during the field testing process.

Content Reaction Form. This form is used in the following situations:

- To record additional goal categories for which no items currently exist in the item collection, and

- To record goal categories for which an insufficient number of items currently exists in the item collection.

Feedback received on the Content Reaction Form helps direct future item searches and item development since it identifies gaps that currently exist in the item collection.

WHAT PRODUCTS ARE AVAILABLE THROUGH THE PROJECT?

Project members receive all of the materials listed below and any new products developed during their year of membership. All materials have been field tested and used by participating districts.

Curriculum Surveys

Six science curriculum surveys that determine the emphasis teachers place on a wide range of topics, concepts, and processes are available for:

- Grades K-6
- Middle School/Junior High
- Biology
- Chemistry
- Physics
- Earth/Space Sciences

Purchase of the survey masters includes written permission to reproduce the copyrighted materials for use within an individual school district. Non-member price; $20 per survey; $100 per set.

Survey Scoring and Reporting Services

The project's scoring service provides rapid turnaround of reports for each grade level and each course surveyed. Special reports are also available (fees to be negotiated based on the type of report requested).

Curriculum Planning Materials

A Curriculum Planning Handbook and support materials (a complete set of seventeen planning matrices) are available to help curriculum committees answer questions such as:

- How do we develop a scope and sequence that will align the curriculum from K-12 and be used and valued by teachers?
- Which textbooks and other instructional materials best meet our local needs?
- Which portions of the curriculum warrant attention when developing and/or selecting tests and other assessment instruments?
- How do we incorporate major concepts and processes into existing science programs?

Non-member price: $150.

Science Test Items

The project has developed a collection of 8,000 test items printed on card stock, from which teachers and evaluation specialists can develop high quality tests. The collection covers a wide range of science topics as well as major concepts and processes that cross science disciplines. Most of the items in the collection have been written by skilled item writers trained and supervised by the project. All items are referenced to a comprehensive science taxonomy.

Ongoing field testing of the items identifies potentially flawed items. These items are subsequently reviewed by a panel of teachers and are either revised or deleted from the collection.

New test items are added to the collection each year. These annual updates are available through continuing membership in the project.

Electronic Version of the Science Test Items

The electronic version of the science test items will be available during the 1988-89 school year for the first time. Support materials and training sessions are currently being developed to provide assistance in the use of the new system.

Specifications for the computer equipment and software needed for the electronic version are available upon request. Some software will be available for purchase through the project; some through Assessment Systems in Minnesota.

Other Publications

A Focus on Science Concepts by David C. Cox. This series of concept papers is designed to assist teachers in implementing concept-based science programs. Each paper focuses on a specific science concept and includes a definition of the concept in teacher language using examples from the contemporary curriculum; instructional objectives desirable for concept learning; sample test questions with a commentary as to their appropriateness for measuring concept learning; and a list of references for additional reading about the concept. Over the next year, papers will be prepared covering 29 key science concepts. The first five papers in this series will be published this spring covering **Cycle, Equillibrium, Force, Model and Perception.**

High School Science Programs: Managing for Excellence by the Northwest Regional Educational Lab A systematic and collegial approach to managing building-level science programs, including a process for aligning the curriculum; five steps to higher student achievement; and the role of the principal in supporting program improvement. This publication combines findings from the study of effective schools and teachers with a goal-based approach to program management.

The Study of Learning Environments edited by Barry J. Fraser. Eight papers presented at the 1985 Annual Meeting of AERA, including "Two Decades of Research on Perceptions of Classroom Environment: and "Nature and Role of Target Students in Science Classroom Environments."

WHAT ARE THE BENEFITS OF MEMBERSHIP

Members receive **all materials** developed by the project over the past five years as well as new materials developed during their year of membership. In addition, they receive a **15% discount** on workshop registration fees.

Members become part of a growing multi-state team dedicated to developing **quality materials and practical staff development activities** which provide members with the skills and procedures necessary to affect change at the local level.

Membership offers the unique opportunity to make a concrete, positive contribution to the improvement of science education. Many members serve on the Steering Committee, the project's policy and program decision-making group. Active participation in workshop planning, item writing, field testing and other project work also increases the skills of individual members.

WHAT ARE THE ANNUAL MEMBERSHIP FEES?*

NEW MEMBERS	**$2,000**
RENEWALS	**$1,000**

Fees for SPONSORING AGENCIES

Membership agreements with sponsoring agencies that join on behalf of a group of school districts are negotiated on an individual basis with the Project Director, Sponsoring agencies might include a consortium of local school districts, an education service district, or a state department of education.

*The membership year runs from July 1 though June 30. Fees include membership in the Northwest Evaluation Association.

HOW CAN MY AGENCY BECOME A PROJECT MEMBER?

Simply return the membership form. Use the order form to indicate which materials you wish to receive. Enclose a check (payable to NWEA Science Project) or purchase order. Please allow threee to four weeks for shipment of the Science Test Item Collection. Shipping charges for the collection will be added to your invoice. If you wish to receive the electronic version of the Science Test Items, please call Susan Smoyer (503/378-4157) for information about computer hardware and software requirements, costs, and vendors.

ARE MATERIALS AVAILABLE FOR PURCHASE BY NON-MEMBERS?

Yes, use the order form to indicate which materials you wish to purchase. Enclose a check (payable to **NWEA Science Project**) or purchase order. Please allow three to four weeks for shipment of the Science Test Item Collection. Shipping charges for the collection will be added to your invoice. If you wish to order the electronic version of the Science Test Items, please call Susan Smoyer (503/378-4157) for more information about computer hardware and software requirements, costs, and vendors.

APPENDIX A

NWEA SCIENCE TEST ITEM COLLECTION
INVENTORY OF ITEMS/GOAL/GRADE LEVEL
February 1988

GOAL CATEGORY	Number of Items			
	K-3	4-6	7-9	10-12
LIFE SCIENCES				
The Cell	-	29	56	106
Zoology	87	174	229	291
Botany	74	73	118	127
Simple Life Forms	2	8	35	53
Ecology	17	70	177	81
EARTH/SPACE SCIENCES				
Geology	97	138	247	30
Oceanography	4	24	190	73
Meteorology	44	79	116	7
Space and Astronomy	44	80	156	18
PHYSICAL SCIENCES				
Measurement	10	7	42	67
Matter: Properties	16	22	57	30
Matter: States of	30	22	23	32
Matter: Changes	16	40	81	125
Matter: Structure	2	38	139	303
Periodic Law/Table	-	-	23	23
Acids, Bases, and Salts	-	-	22	31
Chemical Kinetics	-	-	4	56
Chemical Equilibrium	-	-	-	27
Oxidation	-	-	2	22
Electrochemistry	-	-	3	25
Organic Chemistry	-	-	3	20
Nuclear Chemistry	-	-	23	83
Photochemistry	-	-	-	1
Spectroscopy	-	-	-	1
Chemistry and Society	-	-	1	2
Biochemistry	-	-	4	16
Motion	13	25	74	369
Gravity	4	9	22	17
Electricity and Magnetism	12	42	114	238
Energy	79	79	159	147
Energy Resources	4	50	47	7
Light	9	20	68	139
Modern Physics	-	-	-	3
HISTORY OF SCIENCE	-	1	9	3
LABORATORY	1	2	19	9

GOAL CATEGORY	Number of Items			
	K-3	4-6	7-9	10-12
VOCABULARY	2	2	10	3
CONCEPTS				
Cause-Effect	2	5	7	11
Change	-	3	10	3
Cycle	2	4	13	6
Energy-Matter	4	23	16	9
Entropy	-	-	3	18
Equilibrium	1	-	13	-
Evolution	3	4	10	12
Field	1	1	7	4
Force	-	11	7	4
Fundamental Entities	10	11	13	8
Gradient	19	4	22	10
Interaction	-	6	6	3
Invariance	2	4	15	9
Model	1	2	12	14
Order	9	16	17	3
Organism	1	10	7	4
Perception	10	6	19	8
Probability	2	6	25	23
Population	3	13	16	12
Quantification	3	6	10	5
Replication	-	2	4	8
Resonance	-	1	1	9
Scale	1	8	23	23
Significance	-	-	2	8
Symmetry	3	16	21	18
System	2	13	14	8
Theory	-	3	9	24
Time-Space	3	12	10	13
Validation	-	1	2	7
PROCESSES				
Classifying	40	22	14	3
Communicating	9	14	8	2
Controlling Variables	1	14	25	7
Defining Operationally	6	12	10	1
Designing Experiments	4	12	14	9
Formulating Models	-	2	8	5
Hypothesizing	4	2	15	5
Inferring	38	28	36	14
Interpreting Data	15	52	79	99
Measuring	8	33	20	6
Observing	8	25	4	6
Predicting	31	15	23	8
Questioning	3	2	-	-
Using Numbers	2	10	11	7
Relating Time-Space	5	6	6	1

GOAL CATEGORY	Number of Items K-3	4-6	7-9	10-12
SKILLS	3	2	3	1
INTERESTS	-	-	1	-
VALUES	-	1	4	2
INTERACTIONS	-	-	1	-
CHARACTERISTICS	-	3	1	3

APPENDIX B

SCIENCE CONCEPTS

CAUSE/EFFECT (A relationship of events that leads one to believe that "nature is not capricious." Enables predictions to be made.)

CHANGE (The process of becoming different in which the rate of change may vary from very fast to very slow so that it may be unnoticed in these extreme cases. May involve several stages or mechanisms.)

CYCLE (An apparent pattern in which certain events or conditions seem to be repeated at regular intervals or periods.)

ENERGY-MATTER (Mutually convertible equivalents of interchangeable manifestations of substance which enable something to be moved or changed.)

ENTROPY (An expression of the randomness, disorder or chaos in a collection of things, which always increases in a closed system.)

EQUILIBRIUM (A state of "balance or equality" in which changes or tendencies to change occur in opposite directions, exist or happen at equal rates, or are of the same magnitude.)

EVOLUTION (A series of slow changes that can be used to explain how something became the way it is or predict what it might become in the future. Generally regarded as going from simple to complex.)

FIELD (A region or space in which something influences or affects something else, often without direct physical contact.)

FORCE (A push or pull against resistance.)

FUNDAMENTAL ENTITIES (Units of structure and function useful for explaining certain phenomena.)

GRADIENT (A situation in which the intensity of something varies in a more or less regular pattern.)

INTERACTION (A situation in which two or more things influence or affect each other.)

INVARIANCE (A characteristic of an object of situation which remains constant even though other characteristics may change.)

MODEL (A more or less tentative scheme or structure which seems to correspond to a real structure, event or class of events that are not directly observable.)

ORDER (The belief that there is either order in nature or that humans are able to impose order on nature. Includes the various schemes or patterns used to express this order, e.g., the periodic table of elements.)

ORGANISM (An open dynamic system characterized by the processes of life. May be used as a representation to explain certain nonlife events or things.)

PERCEPTION (The interaction between the human mind and the external world; the mind's interpretation of sensory input.)

POPULATION (A group of fundamental entities having similarities or common characteristics.)

PROBABILITY (The relative certainty, or lack of certainty that can be assigned to certain events happening in a specified time interval or sequence of other events; a number expressing the likelihood that a situation or event will happen.)

QUANTIFICATION (An expression containing a numerical component resulting from measurement of some real or abstract thing, situation or event.)

REPLICATION (A belief that doing the same things will produce the same results if other conditions are the same; a necessary characteristic of scientific experiments.)

RESONANCE (An action within one system which causes a similar action within another system.)

SCALE (A consideration that other characteristics or relationships within a system may or may not change as its dimensions are increased or decreased.)

SIGNIFICANCE (The belief that certain differences that exist or that follow certain actions exceed those that would be expected to be caused by chance alone.)

SYMMETRY (The belief that most, if not all, patterns in nature are structurally or functionally balanced, or independent of direction.)

SYSTEM (A group of things or events that can be defined, at least in part, by boundaries which enable it to be discussed and studied more effectively; a set of parts that function together as a whole.)

THEORY (A connected and internally consistent group of sentences, equations, models, or a combination of these, which serves to explain a relatively large and diverse group of things or events.)

TIME-SPACE (A dimension of the real world which separates things and events; time vs. movement.)

VALIDATION (A belief that similar results obtained by two or more different methods reflect an accurate representation of the situation being investigated.)

SCIENTIFIC PROCESSES

CLASSIFYING (Systematically imposing order on data.)

COMMUNICATING (Exchanging information.)

CONTROLLING VARIABLES (Identifying and managing factors that may influence an experiment.)

DEFINING OPERATIONALLY (Defining something by describing how it works.)

DESIGNING EXPERIMENTS (Planning data-gathering operations to test hypotheses or answer questions.)

FORMULATING MODELS (Devising representations that explain real things.)

HYPOTHESIZING (Tentatively accepting an explanation as the basis for further investigation.)

INFERRING (Concluding from known facts or evidence.)

INTERPRETING DATA (Finding patterns or meanings not immediately apparent.)

MEASURING (Using instruments to determine value.)

OBSERVING (Using the senses to obtain information.)

PREDICTING (Foretelling from previous information.)

QUESTIONING (Raising uncertainty.)

RELATING TIME/SPACE (Describing how duration affects distance and vice versa.)

USING NUMBERS (Expressing ideas, observations and relationships in figures, often as complements to using words.)

APPENDIX C

CRITERIA FOR CONSTRUCTING TESTS WITHOUT RACE/ETHNIC BIAS

1. Eliminate items that call for backgound experience or information which, though common to majority-culture students, may be unknown to students with culturally or linguistically different backgrounds. Be sure that all information needed to get an item right is given in the item, except the learning for which the item tests.

2. Eliminate offensive stereotypic references to minorities.

3. Eliminate color symbolism (e.g., yellow-bellied).

4. Depict human situations which are common to most people.

5. Use names not strongly associated with a particular ethnic group, OR use names from several ethnic groups, evenly distributed.

6. Avoid references to legendary or historical figures that may be seen as ethnic "archetypes."

7. If real situations or events are described:

   Balance selections of content so that non-majority cultural events and perspectives are adequately represented within a test or a set of items.

   Avoid offensive contrasts in the tone of majority vs. minority-subject items (e.g., portraying Third World or minority culture events as "problems" where majority-culture events are portrayed as "achievements").

CRITERIA FOR CONSTRUCTING TESTS WITHOUT GENDER/SEX-ROLE BIAS

1. Eliminate offensive stereotypic references to gender groups.

2. Eliminate "generic" use of male terms (he, man, etc.).

3. In each test, half the references to humans should be to males and half to females.

4. One-half of the references to females should depict them in non-stereotypic or neutral roles.

5. One-half the references to males should depict them in non-stereotypic or neutral roles.

6. One-half of the titles referring to females should not reflect marital status.

APPENDIX D

WRITING GOOD TEST ITEMS--HOW?

1. Carefully define the goal, subgoal, or objective to be tested and the purpose of testing.

2. Specify the item characteristics needed (e.g., the vocabulary, signs/symbols, etc. to be used or excluded for the students, subjects, and purposes involved).

3. Work in small groups to write items for the same goals or objectives and testing purposes. Begin with discussion; spend some time with resource materials (texts, etc.); then write for half an hour to 45 minutes. Stop and share items, noting questions and problems. Agree on improvements and put aside items that the group has trouble "fixing" to everyone's satisfaction. Repeat the process. Before the next session, have all items typed for review and editing.

4. Wait a few days to a week before reviewing items. Writers should review and edit their items and those written by others in the group looking for confusing text or responses, or other problems. Annotate typed drafts of items for an editor to revise, or revise together and annotate for retyping.

5. Have another group review retyped items for race/ethnic and sex-role bias.

6. Have original writers or other qualified reviewer(s) (e.g., an editor, a subject matter specialist, another teacher group) give the items a final check. Decide on the final forms of items and discard or put aside those with unresolved problems.

7. Try out items with students who have been instructed on the goals/subgoals/objectives you're measuring.

8. Use appropriate statistical and/or other validation procedures to determine which items "work": that is, which items the students with the learning get right and the students without it get wrong.

APPENDIX E

CHARACTERISTICS OF A HIGH-QUALITY MULTIPLE CHOICE TEST ITEM

1. Item is logically content-valid. (It measure the goal to which it is related, or it can be used to measure an identifiable goal.)
2. Clear, appropriate, simplest possible text, with terms used accurately.
3. Freedom from racial, ethnic or sex-role bias or stereotyping.
4. No extraneous information; no tricks or traps.
5. No give-aways: answer choices about the same length, no grammatical cues, etc.
6. No use of double negatives.
7. One right or best answer, with plausible distractors. (If the "best" answer is called for, criteria for "best" are included.)
8. Logical ordering of answer choices.
9. All information is provided to choose the correct answer (except that for which the item tests) if the student <u>does</u> have the knowledge or skill the item is written to test.
10. Vocabulary used in the item is standard usage, spelled and punctuated correctly, and appropriate to grade level and subject.
11. Graphs or illustrations are clear and accurate, or could be made so.
12. Judicious (or no) use of humor or whimsey.

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☐ Survey Scoring/Reporting Service[1]	One-time processing for up to 50 surveys included in membership fee. $3.50 per survey over 50.	$4.00 per survey (with $100 minimum)
☐ Curriculum Planning Materials	Included in membership fee	$150
☐ Science Test Item Collection (approximately 7,500 items on card stock)	Included in membership fee	$2,000
☐ Electronic version of the Science test items[2]	Included in membership fee	$2,000
☐ Focus on Science Concepts (Set includes Cycle, Equilibrium, Force, Model and Perception; 5 copies of each concept.)	All publications included in membership fee. Additional copies at non-member price.	$45
☐ High School Science Programs Managing for Excellence		$6
☐ The Study of Learning Environments		

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1 Please indicate if you intend to purchase the project's scoring and reporting service, but do not include this amount in your check or purchase order. You will be billed when your surveys are processed.

2 Available October, 1988.