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# A Tool for Assessing, Implementing, and Evaluating Science Curriculum (K-12) for Iowa Schools

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# A TOOL FOR ASSESSING, IMPLEMENTING, AND EVALUATING SCIENCE CURRICULUM (K-12) FOR IOWA SCHOOLS

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## Introduction

In the fall of 1977 the Iowa Department of Public Instruction (DPI) began to receive many requests for assistance in developing coordinated science programs. Local schools faced with aging science materials, economic constraints, increasing pressure from publishing companies, and decreasing student reading and computing skills needed guidelines for assessing, implementing and evaluating their science curriculum. The purpose of this tool is to provide such assistance.

## National Background

Technology, premised on scientific concepts, advanced rapidly following World War II. So great was the need for scientists that supply could not keep pace with demand. This demand stimulated the reform movement in the area of secondary level science curriculum(1).

Simultaneously, it was becoming more apparent that the economic future of developed nations was integrally tied to their ability to develop and apply knowledge in practical technology. Coping with such rapid technological change required an educated populace, which in turn created a demand for better schools and a higher percentage of college-educated citizens(2).

The National Defense Act and the National Science Foundation (NSF) reflected the faith that the national government had in science as a means of improving national defense. It became apparent that developing the nation's scientific and technological resources would provide greater security than developing agriculture or industry(3).

Throughout the 1940s and early '50s, science textbooks centered upon organized factual topics. Recall of written facts was stressed. The scientific method was presented in the format of dogmatic, confirmatory laboratory exercises. Little emphasis was placed on problem solving within the total program.

Major reform in the science curriculum began in the mid-1950s and leveled off in the late 1960s. During this time, the NSF supported projects that stressed the processes of science. Perhaps its most impor-

tant contribution was the construction of science programs that enabled students, through active participation, to develop an understanding of the nature of science. To construct these kinds of programs, NSF study groups used conceptual schemes and inquiry-based activities that emphasized scientific processes (4).

In many respects the NSF science programs met their short-range goal of increasing science awareness and performance. However, they fell short of their intended, or potential, goal of providing a practical, articulated program that would stimulate continued student interest and develop a scientifically literate society. The need for curriculum articulation and interaction among teachers, however, did increase because of these programs.

Among the most significant problems created by the NSF programs was the demand placed on teachers as a result of the shift in roles from "disseminator of information" to that of a "facilitator to learning."

Every local school district has a responsibility for curriculum development. However, at the local level the limited amount of professional time and financial resources make developing a sequential curriculum difficult. In most disciplines this difficulty results in dependence on commerical interests to develop printed materials and curriculum structures which have had a topical organization. Local districts contemplating a new science curriculum face the difficulty of choosing from among the many ready-made curricular materials.

## Iowa

State departments of education are involved in curriculum, at least to the extent that they make recommendations available to the public school districts.

The *School Laws of Iowa* provides minimum curriculum requirements and standards for approved schools (K-12)(5). Section 257.25 states, where applicable to science:

> **257.25(2) Kindergarten level.** *If a school offers a kindergarten program, the program shall include experiences designed to develop healthy emotional and social habits and growth in the language arts and communication skills, as well as a capacity for the completion of individual tasks, and protection and development of physical being.*
> **257.25(3) Grades one through six.** *The following areas shall be taught in grades one through six:*
>
> *SCIENCE, including conservation of natural resources and environmental awareness*
>
> **Junior High School Level**
> **257.25(4) Grades seven and eight.** *The following shall be taught in grades seven and eight as a minimum program:*
>
> *SCIENCE, including conservation of natural resources and environmental awareness*
>
> **High School Level**
> **257.25(6a through 6j, 7) Grades nine, ten, eleven and twelve.** *The minimum program for grades nine through twelve shall be:*
> **Science** *(four units), including physics and chemistry; the units of physics and chemistry may be taught in alternative years*

In the fall of 1977 the Iowa Department of Public Instruction (DPI) began to receive many requests for assistance in applying the *Code of Iowa* to the development of coordinated science programs. In the spring of 1978 the Iowa Council of Science Supervisors ($CS^2$), in conjunction with the DPI, initiated development of the tool discussed in this article. $CS^2$ is composed of approximately 65 Iowa scientists and science educators representing colleges and universities, area education agencies, local education agencies, and state education agencies.

Some of the material in the complete document is either abstracted or quoted directly from the Council of State Science Supervisors — *The Science Curriculum and the States* (1971)(6) and the *Minnesota Essential Learner Outcomes in Science* (1976)(7).

In the fall of 1978 the DPI science consultant initiated pilot testing of the document in 24 school districts. The participating schools were asked to help refine the philosophy, goals, objectives, and implementation schedule.

The document is intended to provide local schools with a practical guideline for assessing their present science curriculum and/or to develop a sequential, coordinated K-12 program. The model provides assistance in the following manner:

I. It provides an outline for conducting a science curriculum assessment and/or revision.

II. It provides guidelines for assisting schools in developing their science philosophy, goals and objectives.

III. It provides a consensus of recommendations (from 2,000 Iowa science teachers) for grade level blocks (K-3), (4-6), (7-9), (10-12) at which suggested objectives are introduced, emphasized and maintained. It provides a system for evaluating present and proposed science programs.

IV. It provides suggestions for evaluating student achievement within the curriculum. It provides a list for assessing science facilities.

**Outline for Assessing or Revising Curriculum**

| | Proposed Date | Completion Date |
|---|---|---|
| • Establish a representative curriculum committee (principal, guidance counselor, outside consultant, teachers K-12) | _____ | _____ |
| • Schedule time and finances for curriculum committee meetings | _____ | _____ |
| • Review national, state trends and curriculum models available | _____ | _____ |
| • Assess science facilities, equipment* | _____ | _____ |
| • Develop or refine district science philosophy* | _____ | _____ |
| • Develop or refine district science goals* | _____ | _____ |

- Develop or refine district science objectives* _____ _____
- Establish consensus as to placement of objectives in curriculum blocks (K-3) (4-6) (7-9) (10-12)* _____ _____
- Establish consensus as to the degree to which each objective is emphasized within the curriculum by block (K-3) (4-6) (7-9) (10-12)* _____ _____
- Isolate process, content, impact weaknesses and objective duplications _____ _____
- Establish plans for elimination of identified weaknesses (supplement, adoption, etc.) _____ _____
- Identify plan for assessing student achievement within above identified curriculum* _____ _____
- Reassess objectives each year _____ _____

**Guidelines provided in tool*

**Philosophy**

**Science Education as a Basic.** A new generation of scientifically literate citizens is needed to cope with a culture characterized by an advanced technology, rapid change and a complex set of ethical questions. Accordingly, the CS² recommends that all students receive an appropriate education in science in order to develop intellectual skills that are basic to critical thinking, problem solving and decision making.

The study of science offers a heritage of knowledge and a basis for understanding our technological society. Uniquely, science is based upon the notion that humans can test and understand the orderly nature of the universe. Fundamental to this belief is a need for students to develop the logical thought processes of observing, classifying, measuring, predicting, inferring, hypothesizing and experimenting. These processes are best developed through a well articulated K-12 science program that features experimentation and manipulation of materials.

Science activities, built upon each individual's natural curiosity, become self motivating and enjoyable. This involvement can result in presonal gains for students who discover and develop a confidence in their own ability to make decisions. This ability can form a basis for dealing with social, technological medical, and environmental problems that exist in our society.

In addition to developing students' logical thought processes and personal growth, research indicates that involvement with science activities helps students grow in other curricular areas. The evidence shows a significant effect upon reading readiness, the motivation to learn and the ability to acquire oral and written communication skills (8, 9, 10, 11, 12). Science requires a practical use of mathematical concepts and skills. Science is a vehicle for use of the metric system and also provides subject matter for social studies. Therefore, we recommend that:

1. Science be taught as a basic and as an essectial component of the entire K-12 curriculum.

2. Every student experience daily science activities which are designed to develop reasoning skills and understanding of the role of science in our society.

Based upon this philosophy, the CS² committee developed a tool for assessing, implementing and evaluating K-12 science programs. The following is an illustrative example of the tool.

**Goal (K-12):** 1. To develop a scientifically literate society.

Subgoals (K-12): A. To teach and use the science processes as an integral part of basic learning.

B. To impart knowledge of natural phenomena.

C. To use scientific knowledge in understanding the impact of science and technology on the individual, culture and society.

Figure 1 shows an example of the format the document provides. At the present time a total of 60 objectives have been developed: 7 process objectives - Subgoal A; 28 knowledge objectives - Subgoal B; 25 impact objectives - Subgoal C. In addition, the suggested placement of each objective in the science curriculum is provided. By spring 1979 the placement of the objectives within the K-12 science curriculum will be refined from the consensus of 2000 K-12 Iowa science teachers.

### Evaluation

Evaluation of student performance according to the curriculum objectives is being explored with the Iowa Testing Service (ITS) in Iowa City. Objectives may eventually be cross-referenced with science items within the Iowa Test of Basic Skills (ITBS) and Iowa Test of Educational Development (ITED). In addition, Iowa State University personnel are planning to develop a pool of test items for each objective applicable to each block (K-3) (4-6) (7-9) (10-12).

## Summary

The "decade of reform" in education, initiated by the 1965 Elementary and Secondary Education Act, has ended with declining student aptitude scores and alleged government insensitivity to local needs. If local schools are going to be successful, they will need assistance in developing their own reform programs. The purpose of this tool is to provide such assistance.

Should you desire further information about "Tool for Assessing, Implementing, and Evaluating Science Curriculum K-12," contact Dr. Jack A. Gerlovich, science consultant, Iowa Department of Public Instruction, Grimes State Office Building, Des Moines, Iowa 50319.

**Figure 1: Guideline for Establishing Consensus of Suggested Placement of Objectives in Curriculum and Evaluating Degree to Which Objectives Are Emphasized**

| | Consensus of Suggested Placement of Process Objectives in Science Curriculum * (K-3) (4-6) (7-9) (10-12) | Degree to which objective is emphasized in the science program * * By Block (consensus of individual teachers) (K-3) or (4-6) or (7-9) or (10-12) | By Individual Teacher |
|---|---|---|---|
| Subgoal A: To teach and use the science processes as a part of basic learning. | 1 E M M | 1 2 3 4 5 | 1 2 3 4 5 |
| 1. Objective: To develop a student's *observing* skills. (Observing means using the senses to obtain information or data about objects and events.) | | | |
| 2. Objective: To develop a student's *classifying* skills. (Classifying is the process used to impose order on collections of objects and events to show similarities, differences, and interrelationships.) | N I E M | 1 2 3 4 5 | 1 2 3 4 5 |

* Definition of Symbols For Suggested Placement of Objectives in Curriculum

I — Introduce - The first time a topic is presented as a planned portion of the science program.
E — Emphasize - The topic to be stressed.
M — Maintain - The presentation and/or reinforcement of topics introduced previously.
N — Not applicable at this level.

* * Definition of Symbols — For Degree to Which Objective is Emphasized in Science *program*.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| None | Very Little | Some | Quite a Bit | A Great Deal |

## Literature Cited


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9. Carter, G.S. and R.D. Simpson. Science and Reading: A basic Duo. *The Science Teacher.* Volume 45, 3, National Science Teachers Association. Washington, D.C., March 1978. pp. 18-21.


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## Disposal of Hazardous Chemicals

A cadre of 10 chemists has been identified and trained to assist science teachers in Iowa's secondary schools in the redistribution and/or disposal of hazardous chemicals. If science teachers have questions concerning the properties, handling or disposal of any chemicals (including unknown and unlabeled chemicals) in their storerooms, they should call the chemist nearest them for help.

David Drummond, Frank Kilpatrick, University of Iowa (319) 353-5125
Ivan Schwaubaer, University Hygienic Lab., Iowa City (319) 353-5990
Emory Sabottka, Joseph Klinsky, ISU (515) 294-5359
Lee Friell, University Hygienic Lab., Des Moines (515) 281-5371
Wayne Merkley, Ron Kolpa, Ia. Dept. Envir. Qual., Des Moines (515) 281-8925
Leland Thompson, LeRoy McGrew, UNI, (319) 273-6181

For further information call Jack Gerlovich, Science Consultant, Iowa Department of Public Instruction (515) 281-3749.

## Catalog of Curriculum Resources

A catalog of 116 curriculum units for elementary through secondary science levels is available free from The Science Resource Centre, Faculty of Education, Queen's University, Kingston, Ontario, Canada, K 7L 3N6. Each unit is briefly described. Grade level and cost are included.