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ABSTRACT

The theme of the eighth yearbook of the Association for the Education of Teachers in Science (AETS) involves the improvement of instructional practices in science at the middle school level. An initial chapter provides an operational definition of the middle school. Five chapters follow which provide information on various sources of educational objectives for middle school science. One chapter outlines the development of programs in middle school science. The last three chapters describe the improvement of practices in middle school science teacher preparation, in in-service training for middle school science teachers, and reactions from the field regarding the improvement of practices in middle school science. (CS)

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1981 AETS YEARBOOK

IMPROVING PRACTICES IN MIDDLE SCHOOL SCIENCE

Edited by

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Association for the Education of
Teachers in Science

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ERIC/SMEAC and AETS are currently cooperating on a ninth publication. We invite your comments and suggestions on this series.

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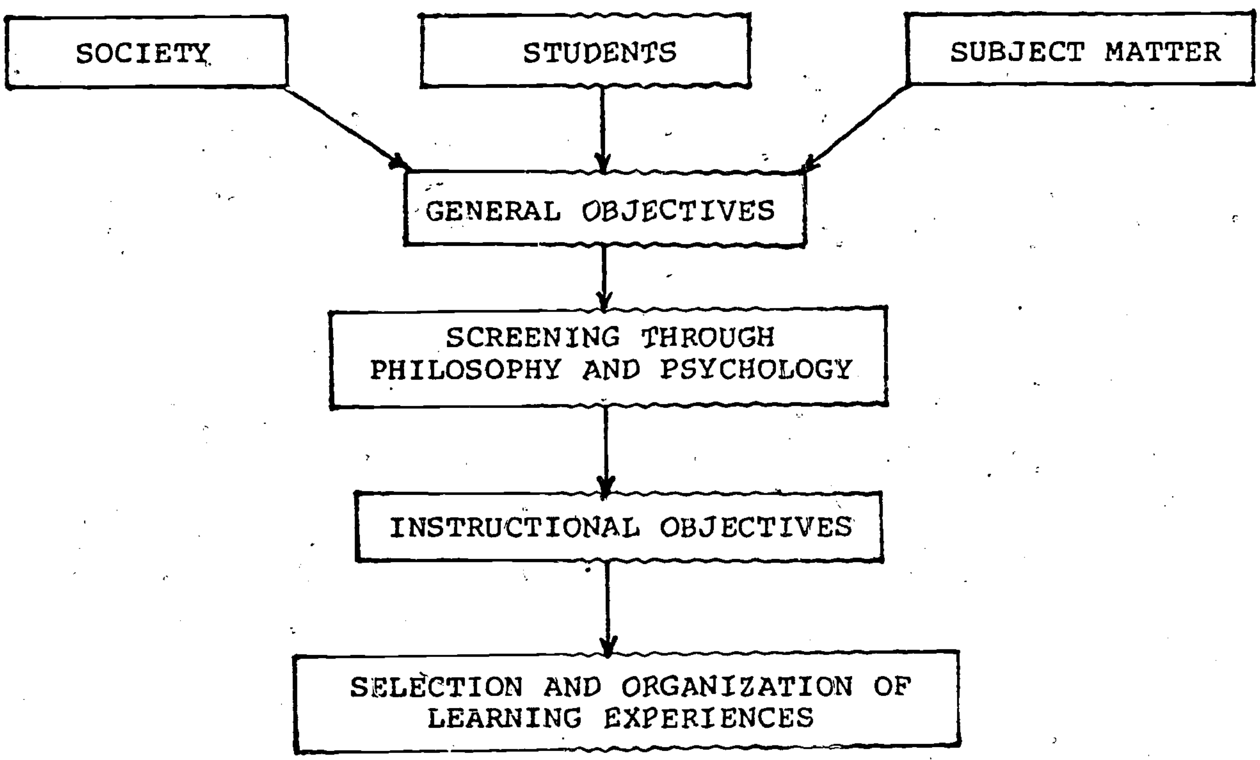
Preface

In 1950 Ralph Tyler first published <u>Basic Principles of Curriculum and Instruction</u>. This discourse identified a number of principles that seem appropriate today in considering middle school practices in science education. Basically we might diagram some of these principles as follows:

FIGURE 1

TYLER'S MODEL OF CURRICULUM AND INSTRUCTION



Using knowledge of the needs and interests of students and responding to the demands of society and school, a set of general objectives is formulated. Once these general objectives are formulated, they are screened by educators and others through any philosophy (or philosophies) that might be operating and by modern psychological thought.

After screening, specific instructional objectives are stated. Using these instructional objectives, teachers and instructional developers select and organize the various learning experiences that, they hope, will result in the attainment of these objectives.

Since this booklet was written, much new knowledge about thought processes has been used by curriculum developers. The psychologies of Piaget, Bruner and Gagne have had great impact on recent curriculum programs. While newer developments such as brain maturation studied by Epstein and hemisphere learning studied by several researchers are being cited more frequently in the literature, impacts on curriculum and instruction have probably been minimal to date. Nonetheless, the appropriateness of this new knowledge, especially at the middle school level, is apparent.

For this yearbook Tyler's model became the framework that incorporated this new knowledge and served as a discussion of improving school practices. Authors were asked to keep in mind the Tyler model as a basis from which to begin writing. Part I of the yearbook may be viewed as a theorectical response to Tyler's model. Part II is a more practical approach in which authors were asked to develop the topics as specifically as possible and to cite real world examples.

In Chapter One Robert Malinka sets the stage by presenting an overview of the middle school model, what it is (characteristics of middle school students), and curriculum and instructional models both theoretical and those being in practice. He ends his work by identifying some persistent problems and asking questions for which the science education community needs to formulate answers. Some of the questions raised by Malinka are answered, at least in part, in subsequent chapters.

Norman Anderson and Ronald Simpson identify and describe characteristics of contemporary life that they feel should be considered in developing a science curriculum. James Conner identifies the contributions that scientists may make to the model by first developing lists of objectives gleaned from many sources and then developing sample bridges among the various lists. He ends by developing lists that may serve as springboards for future thoughts.

Truman Stevens argues that acceptance of the middle school model dictates the acceptance of a basic philosophical perspective. He writes that the learner may have much input into the development of curriculum and instructional processes. These inputs are derived from a variety of needs, including the onset of puberty, development of self-concept, and development of intellect, as well as various academic interests. These needs may be appropriately translated into learner objectives.

General objectives for middle school science may be derived from a wide variety of sources. Burton Voss identifies those objectives that will lead to scientific literacy. The variety of these objectives and the spectrum of sources should prove useful to those who rethink the science objectives for their own schools and school systems.

In his chapter concerning the formation of specific objectives, Larry Yore provides practical illustrations. He relates the formulation of objectives to specific activities of well-established curriculum programs. He offers suggestions to science educators responsible for the selection of learning experiences and ends with examples that integrate science and other subject areas.

Mary McConnell gives us insight into the development of a particular curriculum program and the things that professional curriculum developers consider in designing a curriculum redundant program. Of interest to many will be the impediments to developing effective curricula that she identifies. McConnell states that, while teachers cannot be expected to develop curricula de nova, they can and often do develop curricula by choosing and adapting materials from a variety of sources.

While instruction might be viewed as the implementation of the 7.a curriculum plan, instruction also defines the actual parameters of the plan. With this in mind, Cleminson, Rachelson and Thompson have seen fit to focus on teaching skills and what they call a few teaching strategies in the development of the Memphis State University teacher preparation program. All three models of teacher training described in Chapter Eight (Memphis State University, Georgia Plan, and Iowa UPSTEP) incorporate field experiences to greater or lesser degrees. These and other aspects of the programs are described in the respective sub-chapters. The three programs are vastly different from one another, yet each has useful components that may be incorporated into other teacher preparation programs.

The sub-parts of Chapter Nine address common as well as unique problems in developing in-service programs. Thomas Erb defines characteristics of successful in-service programs while Paul Beisenherz and Alan McCormack address unique concerns associated with large metropolitan districts and geographically disparate smaller systems. Science educators concerned with in-service should find these works helpful.

In the final chapter, prominent teachers and administrators reflect on the statements found in the previous chapters. They sometimes praise and sometimes criticize, but their remarks are always crisp and to the point. Science educators at the college ranks would do well to reflect upon the perceptions of these fine school persons.

It was with some trepidation that I undertook the task of editing the 1981 yearbook. It is with even more trepidation that I conclude its undertaking for I realize that improving practices in middle school science has only begun. Middle school science is much like an anlage; not yet its ultimate form. It will be influenced, by its environment, to grow in many ways. The thoughts of the authors are like so many chemicals that influence the anlage to grow into what it becomes. Hopefully, there will be many mutations of these thoughts, for just as mutations occasionally improve a species, so too the ideas and mutations of the ideas in this yearbook will improve science teacher training, provide new models, provide new areas of research, stimulate better instructional practices, and stimulate development of better curriculum materials. Taken as a whole the essays found in this volume will lead toward improved practices in middle school science.

ACKNOWLEDGEMENT

As in any writing endeavor there are many to thank, those that provide stimulus, encouragement, and critiques as well as other kinds of support. I would like to thank Ertle Thompson, AETS president for giving me the opportunity to undertake this task. Frank Howard, Terry Brooks, Essie Beck, Ken Mechling and Steve Henderson initially provided many of the ideas that are incorporated into this volume. Hans Anderson was also helpful in formulating ideas not only for this yearbook but the one that will follow. It has been enjoyable working with Stan Helgeson and Pat Blosser at ERIC. Lastly, my thanks go to those who helped with typing and phone calls and to those who reflected on and gave guidance to my ideas.

V. Daniel Ochs
Editor

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CHAPTER I

THE MIDDLE SCHOOL: AN OPERATIONAL DEFINITION

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HISTORICAL PERSPECTIVE

The concept of a specialized school program serving youngsters between the elementary and secondary years had its roots in the closing decades of the 1800s and the early years of the 1900s. President Charles W. Eliot of Harvard University, along with other American educators, became concerned about the relatively late age of entering college freshmen. Eliot's concern triggered the formation of the Committee of Ten in 1892. The various committees serving from 1892 to 1918 stressed the rationale that contributed to the concept of the junior high school: (1) better provision in the school program for the needs of adolescents, (2) provision for the exploration of pupil interest and ability, (3) individualization of instruction, and (4) better articulation between elementary and secondary education (De Vita et al., 1970). Eliot advocated the shortening and strengthening of elementary education and enriching the program by introducing the natural sciences, mathematics, and foreign languages (Kindred, 1968). The committee's final report is credited with the organizational beginnings of the junior high school. By 1920, the junior high school as a distinct organizational entity in American education was firmly entrenched between the elementary school and the high school (De Vita et al., 1970).

G. Stanley Hall (1905) is generally credited with the birth of intermediate education in the United States. His two-volume book, Adolescence, suggested there was an adolescent age that required its own in-between level of schooling--identifying three, rather than two, periods in human growth and development. The Committee on Six Year Courses of Study in 1905, was appointed to study and recommend a suggested curriculum for a six-year secondary school. Among its recommendations was a curriculum for grades seven and eight (Kindred, 1968).

The Commission on the Reorganization of Secondary Education, in 1913, reaffirmed the 6-6 plan of school organization, but also suggested there should be a three-year junior high school program, containing grades 7, 8, and 9. In the junior high school period, emphasis was to be placed on the attempt to help the students explore their own aptitudes and to make at least provisional choices of the kinds of work to which they would devote themselves. In the senior high school period, emphasis was to be given to training in those chosen fields.

In the junior high school the gradual introduction to departmental instruction, some choice of subjects under guidance, promotion by subjects, prevocational courses, and a social organization that would call forth initiative and the development of a sense of personal responsibility for the welfare of the group were advocated as being educationally sound practices (Kindred, 1968).

Little agreement exists as to who was the first in organizing a junior high school. Richmond, Indiana, in 1895, had grades 7 and 8 organized separately; Providence, Rhode Island, in 1898, had a 6-2-4 plan; Baltimore, Maryland, in 1902, had a 6-3-2 organizational pattern; and Kalamazoo, Michigan, in 1902, offered a 7-3-2 plan. The years of 1901-10 are considered the real beginning of transitional schools, with school systems in Columbus, Ohio, and Berkeley, California, leading the way (Kindred, 1968).

Administrative factors, such as the need for new school buildings and overcrowding, added impetus to the push for intermediate schools after World War I. By 1930, almost half of the secondary students attended a reorganized school. Junior high school numbers increased at a phenomenal rate during the next 40 years. Only 55 separate junior high schools had been established by 1920. The number rose to 1,842 by 1930, and 7,143 by 1964. Combination junior-senior high schools rose from 828 in 1920 to a high of 10,130 in 1959 and declined to 6,042 by 1964. Four-year senior high schools increased to a high of 16,460 in 1930 and declined to a low of 7,173 in 1964 (Kindred, 1968). The overwhelming majority, more than 70 percent, of junior high schools or intermediate schools consisted of grades 7, 8, and 9. However, subsequent educational developments brought increased pressure to put the ninth grade back into the high school.

The furor of the post-Sputnik concern for academic excellence in the late 1950s and early 1960s contributed to the emergence of a new entity in American education: the middle school. Although the basic philosophy of the middle school closely paralleled that of the junior high school, it appeared that, due to several factors, the 6-3-3 organizational pattern was no longer the most appropriate for the middle grade school. Among these factors were: (1) the belief among American educators that children of all ages were maturing faster intellectually, socially, emotionally, and personally than in the 1920s and 1930s; (2) changes in our culture; and (3) developing educational concepts (Eichhorn, 1974).

A major concern of advocates of the middle school concept was not in the philosophical base of the junior high school, but instead in its lack of the ability to afford certain experiences in school which were, indeed, mentioned in early writings supporting the junior high school concept. Thus, the middle school began to emerge as an alternative organizational pattern which would provide the most appropriate experiences for the 10-14 age group, according to what was known about their developmental characteristics.

The current concept of middle schools began to develop in the late 1950s as a result of a growing dissatisfaction with the structure and program of the junior high schools. Other factors that created a receptive climate for middle school proposals for reorganization were: (1) changes in maturation patterns, (2) problems of children moving from level to level, (3) new educational ideals, (4) developments in learning theory, (5) innovations in educational methods and materials, and (6) changes in society (Kindred et al., 1976).

Critics of the junior high school began to question what they viewed as the tendency to copy the senior high school's rigid departmentalization, subject-centered curriculum, high-powered interscholastic athletics, and sophisticated student social activities. More educators began to believe that the majority of junior high school programs were not appropriate for pre- and early adolescents (Summary of Research on Middle Schools, 1975).

Where and when the middle schools really began is uncertain. Bay City, Michigan, is most often credited with the implementation of the first middle school in 1950. The program included grades 5 through 8, in self-contained classrooms, except for special subjects such as related arts (Kindred, 1976). Pioneer middle schools emerged in Centerville, Ohio; Barrington, Illinois; Eagle Grove, Iowa; Mt. Kisko, New York; and Upper St. Clair, Pennsylvania, in the early 1960s. Since that time, the middle school movement has gained momentum rapidly (Alexander, 1974; Eichhorn, 1974).

Only 499 middle schools had been established by 1966. The number rose to 1,101 by 1968, and to 3,723 by 1974 (Alexander, 1977). Today, there are more than 6,000 middle schools across the country (Cawelti, 1977).

There can be no question that the popularity of the middle school as an alternative organizational structure for the middle level of education emerged rapidly. Some educators believe that the middle school movement is simply a convenient excuse to erect new buildings to relieve overcrowding or to achieve racial balance. Others insist that the increased concern for the transescent (pre-adolescent) learner's unique characteristics is the chief factor responsible for the change. Middle schools have been established for many different reasons; regardless of the reason, the conversion to the middle school concept is now a national, even international, trend. Some believe that the major reason for the continual creation of new middle schools is that the movement is a "grassroots" movement, having its roots in educators dedicated to the process of providing relevant educational experiences for students in the middle grade age group.

CHARACTERISTICS OF MIDDLE SCHOOL STUDENTS

All educators who will work with middle school students must be familiar with the characteristics of the age group so as to be able to effectively identify and deal with their needs. Such knowledge will bring about a closer, more effective working relationship between the teachers and their students. Essential prerequisites to the identification of the purposes and functions of the middle school are an awareness and understanding of the specific and general characteristics of the transescents who will be served by the school. While considerable overlapping and interrelatedness between and among the characteristics of this age group exist, most generalizations may be identified according to the following: (1) physical development, (2) mental/intellectual development, and (3) social/emotional development.

Physical Development

In transescence, a period of pronounced and accelerated physical development commences, marked by increasing height, body breadth and depth, heart size, lung capacity, and muscular strength. Transescents grow at varying rates and begin their rapid growth at different ages. The growth pattern is usually the same for all boys and girls, but there are wide variations in the timing and degrees of the changes. The sequence begins between the ages of 8-12 in girls and between 9-13 in boys. Normally this period ends for girls between the ages 15-18 and for boys in the period from 17-20. Girls develop faster than boys. A 13-year-old girl is closer to being a woman than a 13-year-old boy is to being a man. Boys tend to lag a year or two behind the girls in the physical growth cycle. However, the sequential order in which development occurs is relatively consistent in each sex. The age of the greatest variability in physical size and physiological development is about 13. These growth patterns make middle school students unique when compared with any other age level.

Interest patterns tend to follow physical changes, although size and maturity do not necessarily proceed together. The incommensurate growth of heart and body may result in functional heart murmurs. Bone growth is often faster than muscle development, and bones may lack the protection of covering muscles and supporting tendons. The bones are quite susceptible to damage in the epiphyseal areas of growth during intense sports competition. This uneven bone-muscle growth also results in a lack of coordination; poor body mechanics are evident in many students. A wide range of individual physical differences among students in pre-pubertal and pubertal stages of development appears.

Transescents are characterized by extreme restlessness and need to have a daily release of physical energy. They may feel that they have unlimited sources of energy and unlimited resistance, but they tire easily and are reluctant to admit it. The tendency to over-exert may result in chronic fatigue.

The acceleration and unevenness of physical development and physiological changes in transescents may have many emotional and psychological side effects. Transescents are likely to be disturbed by awkwardness resulting from disproportionate changes in weight and muscle development and are sensitive to the changing contours of the body. They have difficulty in accepting the changes in their own bodies, and in realizing that peers may develop differently and that each individual is unique. The variety of growth patterns frequently engenders anxiety about the normality of one's own development; deviations from cultural models of physical efficiency and physical attractiveness tend to upset both boys and girls.

Slowness of development is a particular cause for concern. The girl may ask herself why her breasts are not developing. The boy is worried because his genitals have not grown as much as those of boys he knows. Shortness, tallness, crooked teeth, acne, obesity, and many other physical characteristics also cause great worry. It is a rare youngster who is never worried during this period with the question: "Am I normal?" (Gatewood and Dilg, 1975).

Social/Emotional Development

Personality development is an important part of the emerging adolescent's transition from childhood to adolescence. The educational process preceding, during, and following the middle school years should ensure continuous progress in this phase of life. Physical, intellectual, and personality development all are important ingredients that need constant attention. Personality development embraces those areas that pertain to the individual's interaction with his or her social milieu. Four major domains of social/emotional development are: (1) self concept, (2) sex role identification, (3) peer influence, and (4) emotional control. Other features such as valuing, dependence/independence, role playing, peer pressures, and socialization would be more specific parts of the total picture and incorporated in the four spheres mentioned (Gatewood and Dilg, 1975).

Self-Concept. During the transition from childhood to adulthood the emerging adolescent develops a self image. "How do I look in the eyes of others?" and "How do I look in my own eyes?" are questions of extreme interest to the individual. These are important to emerging adolescents as they assess themselves, endeavoring to present a positive image for their peer group. Conformity is high at this particular age level as peer acceptance is a dominant concern (Gatewood and Dilg, 1975).

During this time of life the emerging adolescents begin to find their unique "selves" and to focus attention on those "selves." The conflict between dependence and independence in the family structure deepens as they begin to leave childhood and enter adulthood. Parents and other adults have difficulty in understanding why these young individuals fluctuate between interests. Personal appearance, attitudes expressed toward the family and other adults, acceptance by peers and adults, all have their impact upon the transescent's self-concept (Snyder and Kilby, 1976).

Sex Role Identification. As transescents formulate a self-concept, they also encounter what it means to be a male or a female. Individuals are in the process of learning to feel, think, and act in a sex role agreeable with themselves. Certain roles are formed and exhibited through definite types of behavior which may be either good or bad. A major task for emerging adolescents is to identify their own sex roles and the behaviors inherent in those roles. Until the middle school years, the individual has not been required to exert the needed de[illegible] of effort to finally ascertain an appropriate sex role (Snyder and Kilby, 1976).

Peer Acceptance. Emerging adolescents exhibit great concern for peer acceptance and approval. To be socially accepted by the peer group is all important. The will of the group often creates a compulsion for conformity in areas such as dress, language, possessions, and behavior. This explains the indifference some transescents exhibit to the adult population, especially administrators, teachers, and parents (Georgiady and Romano, 1977).

There is a continuous shift of friends with whom the transescents will associate. Changing needs, interests, desires, and wishes present problems. At the beginning of the middle school years, most boys loathe girls, but most girls like boys. Each tend to stay with their own sex most of the time. Later, boys begin to tease the girls, and in some cases, will steal loose articles of clothing, such as a jacket or sweater. In the later middle school years, both sexes prefer mixed parties (Georgiady and Romano, 1977).

Peer pressures reach peak levels during this stage of development. Administrators, teachers, and parents must realize that these pressures may exert a greater control over early adolescent behavior than do adult influences (Snyder and Kilby, 1976).

Emotional Control. The emerging adolescents' emotional behavior will fluctuate rapidly from amiable and content to aggressive, belligerent, and argumentative. At times they will be either cheerful, affectionate, or timid -- or at other times hurt, sad, jealous, or competitive. Anger may be intense, and recovery takes longer than when they were younger children (Snyder and Kilby, 1976).

Emotional development of emerging adolescents, if plotted on a graph, would have many peaks and valleys. Attitudes toward school may be very enthusiastic or show resilient resistance. Coping with physical changes, endeavoring to gain independence from the family, and becoming persons in their own right--all of these present emotion-laden problems of adjustment during this transitional period. At no other time in life is an individual likely to encounter such a diverse number of problems simultaneously (Gatewood and Dilg, 1975).

Mental/Intellectual Development

Mental growth is concurrent with physical maturation. Around the onset of pubescence, some transescents will begin to develop the ability to carry out formal as well as concrete intellectual operations. The stage of formal operations is the final stage of intellectual development preparatory to adult thinking. This stage's main property is the ability to deal with not only the real, but also with the possible and the abstract. Some students will begin to hypothesize and go beyond what might be--that which may be discovered to be true. A high degree of intellectual curiosity is also generally characteristic of this developmental stage.

The cognitive maturation of emerging adolescents is highly variable from one student to another, thus calling for individualized curriculum experiences. Students display a wide range of skills, interests, and abilities unique to their own developmental patterns.

The realm of mental/intellectual growth characteristics has received considerable attention recently, due to the research conducted by Dr. Conrad Toepfer, Jr., and Dr. Herman Epstein, in the area of brain growth. Also relevant to this area are the research findings currently available which deal with cognitive skills attainment levels of children from age 5 through age 18. A study of the literature gives the percentages of children in the various cognitive levels at every school age, and for each age there are at least two independent studies showing similar percentages. And, it has been possible to find evidence that the distribution of percentages is quite similar in all Western countries (Maynard, 1979).

TABLE I

COGNITIVE GROWTH AND DEVELOPMENT*

Age (years)	Pre-Operational	Concrete Onset	Concrete Mature	Formal Onset	Formal Mature
5	85	15			
6	60	35	5		
7	35	55	10		
8	25	55	20		
9	15	55	30		
10	12	52	35	1	
11	6	49	40	5	
12	5	32	51	12	
13	2	34	44	14	6
14	1	32	43	15	9
15	1	14	53	19	13
16	1	15	54	17	13
17	3	19	47	19	12
18	1	15	50	15	19

*from Maynard, 1979, p. 4.

It should be noticeable that by far the greatest number of students in the middle school age group, ages 10-14, are at either the "concrete onset" or "concrete mature" level in terms of their cognitive attainment. The matching of instructional tactics to the thinking levels and styles of the children would seem to be the first task of any educational strategy (Maynard, 1979).

The findings of Epstein (1978) have provided new insights concerning the mental/intellectual capabilities of middle school students. Figure 1, based on his research findings, provides an indication that in the middle school age group, a brain growth hiatus occurs at some time during the period of 12 to 14 years of age. The educational implication is that during this hiatus, or plateau period, little increase in intellectual abilities will be evident. Therefore, middle school educators should consider the use of this period of time to strengthen skills that have already been acquired, and not to introduce students to new cognitive inputs which would only serve to provide a "turn off" in the students (Maynard, 1979).

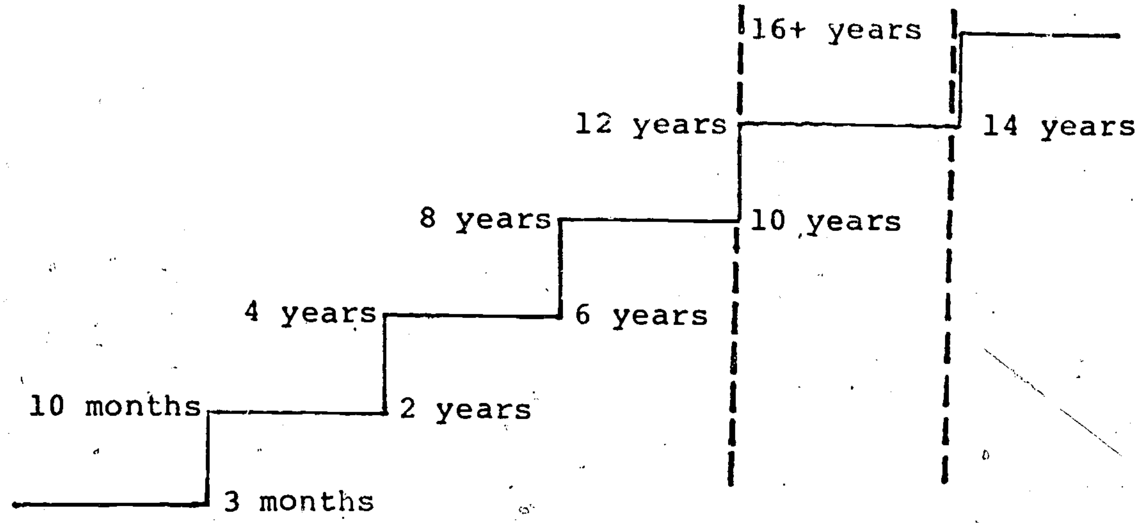

Figure 1. Cognitive Growth and Development of the Middlescent Learner*

*Maynard, p. 5.

Although this chart does not indicate the loss in mental age of the students during the periodization times, research findings indicate that in the age group of 12-14, students will grow in mental age only approximately six months during this 24-month chronological growth period. This constitutes the greatest periodization found in any of the plateau periods during the period of birth through 17 years of age, when the brain is fully grown.

Transescents prefer active involvement to passive receptivity. Intellectual activity is especially interesting to them when related to their immediate goals or purposes. They tend to be intellectually uninhibited. They like to discuss some of their experiences with adults and have a tremendous potential range of creative expression and appreciation in the arts and humanities. They desire a better understanding of their individual abilities, have a strong desire for approval, and are easily discouraged if they do not succeed. They are capable of exploring and selecting learning materials and experiences on their own, to some degree. However, only to a very limited degree can they be trusted to assume responsibility for their own learning, independent of external means of teacher control.

CHARACTERISTICS OF MIDDLE SCHOOLS

Program Goals and Objectives

The middle school curriculum, which consists of the total offerings of programs and activities of the school, must be based on a well developed philosophy. The curriculum should not be arbitrarily developed, teacher-oriented, or academically prescribed. If this happens to occur, teacher-learner activities will tend to be structured in the same manner as those of the traditional junior high school. Thus, the end result will be a middle school program within which transescent students cannot effectively function (Stradley, 1971).

Therefore, a carefully thought-out middle school philosophy is essential. It will serve as a guide in developing not only the general organizational structure, but the curricular and co-curricular programs as well. According to Batezel (1971), the following premises should be considered:

a) A good middle school ought to provide for the gradual transition from the typical self-contained elementary classroom to the highly departmentalized high school.

b) Provision should be made by program and organization for each student to become well known by at least one teacher.

c) The middle school ought to exist as a distinct, very flexible, and unique organization tailored to the special needs of pre-adolescent and early adolescent youths. It ought not to be an extension of the elementary school nor seek to copy the high school.

d) The middle school ought to provide an environment where the child, not the program, is most important and where the opportunity to succeed exists (p.153).

The overall goal of a middle school is to provide opportunities for pre- and early adolescents to discover their own unique personal qualities and potentials in an environment which is responsive to their needs. The goals, aims, and objectives identified should provide the framework needed to develop a sound middle school philosophy. The educational program, in order to be meaningful and effective, must grow out of and reflect the underlying rationale of the school. Since the middle school rationale stresses the transitional nature of pre- and early adolescents, then, out of necessity, the instructional program must be developed on the bases of transition and change (Stradley, 1971).

A relevant curriculum is developed in terms of the students. The students are the plans from which the educational program is built and will be the determinants of its effectiveness. A relevant curriculum can exist only within a personalized, humanized educational structure--a structure that facilitates individual student-teacher interaction (Stradley, 1971).

Curriculum Models for Middle Schools

Once accepted that the middle school serves a unique student population in terms of developmental characteristics, it becomes apparent that the scope and sequence of the curriculum must follow an appropriate developmental pattern. The direction and pace of the intellectual growth of the children must be considered foremost in developing a curriculum model. The curriculum must be designed to accommodate the social, physical, and emotional levels found in this age group, in addition to the variety of intellectual levels.

Several curriculum models have been widely publicized and may be considered for implementation. One such model, developed by Pumerantz and Galano (1972), identifies three curriculum areas: (1) Humanities, which involves an awareness of our culture, past and contemporary, and our relationship to both our universe and ourselves. The courses which generally fall into this area would include English, social studies, and science, all with possible interrelationships with art, music, and mathematics. (2) Sequential, which stresses logical, sequential, and cognitive learning experiences. Courses included would be mathematics, foreign language, reading, and physical education, all having possible interrelationships with music and art. (3) Personal Development, which emphasizes the understanding of both physical and social growth. Experiences should include exploratory projects, community activities, independent projects, enrichment projects, performing projects, technical teaching, and student-managed projects. In this model, remediation is considered an integral component in each of the three areas.

Eichhorn (1966) suggests the following guide to curriculum modeling: (1) Analytical, which includes mathematics, science, and language, areas which stress logical, sequential, and cognitive learning experiences; (2) Expressive Arts, which includes the fine and practical arts, creative expression, performing arts, and world cultures, through the stimulation of creative, divergent mental and emotional development; and (3) Personal Development, which encompasses the area of physical education and provides for experiences that will enhance the child's growth and development, including social dynamics.

The model which is probably most frequently used is that provided by Alexander (1968), which includes: (1) Learning Skills Areas, which give learners a continuation and expansion of basic communicational and computational skills development begun at the elementary school level. (2) General Studies Areas, that provide for an awareness of the students' cultural heritage and other common learnings essential to civic and economic literacy. Content would involve the use of major concepts and themes being drawn from the disciplines of literature, social studies, mathematics, science, and the fine arts. (3) Personal Development Areas, gives attention to personal and remedial needs. This component allows for the exploration of personal interests, and encourages the use of student-managed enterprises and work projects.

The placement of various courses into one of the three categories provided in each of the models is not the primary concern. A middle school curriculum is most effective when the program has a balance of course offerings and provides experiences which meet the needs of the emerging adolescent learners. Middle school curriculum provisions can be divided into three segments for convenient analysis. These include the required portion of the curriculum in which all students must take part, elective offerings, and co-curricular activities.

The major subjects required of all students at all grade levels in the middle school are language arts, social studies, mathematics, science, health, and physical education. Other subjects required to a certain extent in the middle school years are agricultural education, home economics, industrial arts, music, art, vocal music, instrumental music, and typing (Kindred et al., 1976).

Elective subjects normally offered in the middle school are agricultural education, home economics, industrial arts, art, vocal music, instrumental music, typing, speech, foreign language, modern mathematics, and minicourses. Instrumental music, vocal music, and foreign language are the most offered electives. Agricultural education, home economics, industrial arts, and art are also available, although not as often as music and foreign language. The remaining electives are offered even less frequently (Kindred et al., 1976).

Middle schools are rarely without a co-curricular activity program of some kind. Co-curricular programs usually offered include band, orchestra, chorus, glee club, student government, student publications, intramural athletics, interscholastic athletics, speech, debating, dramatics, and outdoor activities (Kindred et al., 1976).

Curriculum Implementation

The middle school curriculum is a fertile area for the implementation of changes so desperately needed by transescent students. The manner in which the curriculum is implemented has much to do with whether or not the school's mission is achieved. Therefore, a brief examination of selected aspects of implementation is in order.

The middle school, as a product of change, must be an agent of change. The professional staff must continue to develop and implement new programs and new methods if the education lag is to be diminished through the middle school, and if the curriculum is to be kept in harmony with the changing times (Stradley, 1971).

Organization and Age/Grade Range

In terms of personal, social, and physical characteristics, sixth-grade students are more like seventh-grade students than they are like fifth-grade students. The reason is related to the onset of puberty, which has not yet begun for most fifth graders. Ninth-grade students are more compatible with tenth-grade students than with eighth-grade students in terms of physical, social, emotional, and intellectual maturity. Based on these findings, a 6-8 grade organization would appear to be most appropriate for the transescent (Snyder and Kilby, 1976).

Two prevailing grade patterns have been identified in the literature. Typically, middle schools are organized on either a three-year program, which includes grades 6, 7, and 8, or a four-year program which also includes grade 5. Compton (1976) reported on national surveys of middle schools taken in 1968, 1970, and 1974. Results of the surveys indicated that the 6, 7, and 8 grade organization was most popular, accounting for approximately 60 percent of the total from responding schools. The 5-8 grade organization was second in popularity, varying from 23.4 percent in 1974, to 27.3 percent in 1968. Viewed in combination, the two grade organizational patterns accounted for approximately 85 percent of the responses in each of the three surveys taken. A more recent survey, conducted by Brooks (1978), indicated that nearly 90 percent of the responding schools taking part in the survey, had grades 5 or 6 through 8.

Research on middle school organization does not conclusively demonstrate the superiority of any one organizational arrangement over all of the others. The decision as to the form of the middle school grade organization in a given school district or community will be made on practical grounds and on the basis of social, economic, and administrative viability. Many middle school authorities agree that any one of a number of organizational patterns is acceptable if it gives identity to youths during early adolescence, includes at least three grades to assure greater stability, and brackets those grades in which significant numbers of students reach pubescence (Alexander, et al., 1969).

The horizontal organization for middle schools should provide a personal approach to learning which results in a concern for each student. This can be accomplished by incorporating elements of some departmentalization with some self-contained and block-time provisions, team teaching, interdisciplinary approaches, single subject teaming, and individualization with a balance suitable to each middle school. Increased teacher-student guidance and appropriate instructional methods are necessary for this age group. The middle school should provide for orientation and an exploration of educational opportunities and experiences in the world of work, living, and leisure (Snyder and Kilby, 1976).

The American educational system places almost complete reliance on a graded school as the vehicle for vertical progression. The basic assumption underlying the graded system is that the amount of work to be done in a school year can be identified and packaged in first, second, or any of the following grades, through high school. If at the end of the school year instructors determine that the pupil has completed a fixed portion of the work, he or she is passed or promoted to the next grade; if not, he or she may be required to start over in the same material at the beginning of the next school year. The alternative to a graded system is a non-graded, or multi-graded, or continuous progress system, or a system in some way combining these plans. The graded system and all of its components such as graded textbooks, report cards, grade level expectations, promotion and retention policies, and graded achievement tests are so much a part of our educational heritage that American schools persist in following the system in spite of convincing evidence of its inconsistency with current psychological insights (Alexander et al., 1969).

The appropriateness of rigidly graded systems of vertical progression is being questioned by some educational leaders. They assert that:

a) Children entering the first grade have a range of from three to four years in their readiness to profit from a graded concept of schooling.

b) By the time students approach the end of the elementary school, the initial spread has approximately doubled.

c) The achievement range among students begins to approximate the intellectual readiness to learn soon after first-grade children are exposed to normal school instruction.

d) Differing abilities, interests, and opportunities among students cause the range in certain specific attainments to surpass the range in general achievement.

e) Individual student patterns differ markedly from learning area to learning area.

f) By the time students reach the intermediate elementary grades, the range in intellectual readiness to learn and in most areas of achievement is as great as, or greater than, the number designating the grade level.

g) By the time students reach the fourth or fifth grade, more than half the achievement scores in a class are above and below the grade level attached to the group. Thus, there is no such thing as a fourth-grade class or a fifth-grade teacher, regardless of the labels within our conventional structure (Alexander et al., 1969).

Implications for Vertical Organization

The vertical organization of the middle school should provide for a continuous, unbroken upward progress of transescent students, with due recognition of the wide variability evident in every aspect of their development. Middle schools should give careful consideration of promising alternatives to traditional graded schools--non-graded, multi-graded, and continuous progress plans. The vertical organization plan chosen must allow for optimum individualization of curriculum and instruction for a student population characterized by great variability (Alexander et al., 1969).

OPERATIONAL TRENDS AND ISSUES

Teacher Preparation and Certification

The preparation and certification of teachers for the middle school level is fast becoming a national phenomenon. A national assessment conducted by Pumerantz in 1968, the first of its kind, showed that only two states, Nebraska and Kentucky, made provisions for granting certification to teachers for the middle school level (Pumerantz, 1968). A follow-up study by George et al., (1975) provided evidence that this number had increased number had increased to eight. The states which were added included: Colorado, Florida, Indiana, North Carolina, Minnesota, and West Virginia. Results of this 1975 study also showed that some 14 other states indicated there was discussion/planning occurring in this area (George et al., 1975).

The most recent survey, by Gillan (1978), disclosed that the number of states possessing some form of certification for middle school teachers was 14. The states which were added since the 1975 study included: Arkansas, Georgia, Iowa, Michigan, Ohio, Rhode Island, South Carolina, and Texas. Gillan also found in his study that 13 other states indicated a move in this direction. Since Gillan's survey, information has been received that the following states have either added a middle school teacher certification program or are in the process of doing so: Alabama, Kansas, Massachusetts, Missouri, Utah, and Wyoming.

An examination of certain conclusions drawn from the Gillan study tends to indicate that there are definite differences between teachers certified to teach at the middle school level, and those teaching in middle schools but who were certified originally at another level. They are presented to support the premise that effective middle school programs are found in those schools where certified middle school teachers are found working with transescent students.

a) Certified middle school teachers have a more positive attitude toward the middle school than do teachers certified at other levels.

b) Certified middle school teachers place greater emphasis on "team teaching" and "student planning in scheduling" as a part of the middle school program than do teachers certified at other levels.

c) Certified middle school teachers are more satisfied with employment at the middle school level than are middle school teachers certified at other levels.

d) Middle school employment stability is more evident among certified middle school teachers than among middle school teachers certified at other levels.

e) The certified middle school teacher is teaching in the middle school as a matter of first choice while the initial assignment of middle school teachers certified at other levels is based on factors other than first choice.

f) The need for increased emphasis on "Early Adolescent and Pre-Adolescent Psychology" and "Teaching Methods and Materials for the Middle School" in middle school teacher education is recognized by both certified and other middle school teachers.

g) Certified middle school teachers are more satisfied with their subject area preparation than are those middle school teachers certified at other levels (Gillan, 1978).

In addition to the movement which is apparent on the part of state departments of instruction in implementing certification alternatives at the middle school level, several exemplary undergraduate/graduate teacher preparation programs have emerged. Included in a listing of such schools would be: Gordon College, Wenham, Massachusetts; Appalachian State University, Boone, North Carolina; the University of Georgia, Athens, Georgia; the University of Florida, Gainesville; the University of Northern Colorado, Greeley; the University of Wyoming, Laramie; and Findlay College, Findlay, Ohio.

An examination of the program components of each of these institutions, along with those of other institutions which have, or are, developing programs, provides evidence that the teacher preparation programs for the middle school level are, indeed, unique and different than the elementary and secondary certification programs.

If the students found in middle schools are truly unique in terms of their developmental characteristics, and if middle schools are to provide learning experiences which are unique in a program which is based on the learner characteristics, it stands to reason that unique teacher preparation and certification programs must continue to be developed. Only in this way can teachers be provided to work in middle schools who are knowledgeable of, and committed to, the philosophy of middle school education.

Standards and Guidelines

Another area of interest which currently appears to be an important topic is the development of approved standards/guidelines for middle schools. Historically, elementary and secondary schools have been included in state adopted standards and/or guidelines, however, middle schools have only recently been added in many states. A survey conducted from the National Middle School Resource Center in 1978 provided the following information: (1) some 25 states currently have standards and/or guidelines for middle school education programs, and (2) an equal number (but not necessarily the same states) indicated the presence of an individual, department, or division at state department level, charged with responsibilities for middle school programs in their respective states (Malinka, 1978).

Involvement with middle school matters is increasing both at the state department level through the creation of middle school standards and/or guidelines, and at the college and university level in developing programs for the preparation of middle school teachers. These signs provide clear indicators that in the coming years the position of the American middle school as a distinct and necessary entity in the K-12 educational continuum will be enhanced greatly.

Minimum Competency vs. Affective Education

A fact of life which must be accepted is the growth, and intensity, of minimum competency programs throughout the United States. These programs have emerged as a result of findings which indicate that students today are achieving at a rate which is below acceptable standards, especially in réading and mathematics although the other course offerings are also under scrutiny. There is no question that attention must be paid to the achievement levels being attained by each student in our schools. However, there may be a danger that such intense involvement in only the cognitive skills areas will cause a de-emphasis in a most critical facet of middle school education, and one which is vital for students at this age level--affective learning experiences. The growth and development patterns of these students, coupled with what we have learned about such patterns, indicates that the middle school level is probably the final opportunity in many instances to work with students to help them develop a positive set of values concerning themselves, their peers, their teachers, and their families.

The teacher-as-an-advisor concept, supported now for several years in certain schools, appears to be one where great growth is taking place nationally. Middle school students must be exposed to experiences and discussions about areas of concern to them and their peers. Teachers must be involved with their students on a more personal level and must be able to assist students in the decision making process, as decisions made at this age might very well carry lifelong implications for directions some of the students will take.

The need for affective education at the middle school level cannot be denied. We are constantly bombarded with statistics concerning increased use of alcohol and drugs in this age group, increases in pregnancies and suicides, and the effects of an increasing number of "one parent" families in the United States. A recent national study conducted by the Kettering Foundation (Brown, 1980) cited U.S. Census Bureau statistics which must be considered vital to teachers who work with middle school-aged children. From the statistics one can infer that 48 percent of school children during the next decade will come from one-parent homes. The study also shows that children from these one-parent families represent more discipline problems, by a three-to-one ratio; a higher dropout rate, by a nine-to-five ratio; more expulsions, by a nine-to-one ratio; and a higher incidence of children being classified as juvenile offenders, by a sixteen-to-three ratio.

Further, a need for emphasis on affective education in middle schools is found in the results of a study conducted by the National Institute of Education and entitled "Violent Schools--Safe Schools" (National Institute of Education, 1978). The authors surmise that junior high schools pose relatively high risks of violence, compared to other places, and that this is due, in part, to the concentration in one place of a large number of youths, who tend statistically, to commit more violent acts than do people in other age categories. Effective middle schools are those which recognize the importance of affective education as an integral strand of the total program. Provisions must be made for students to have positive kinds of experiences in affective areas so as to curb the runaway increases in many important areas, and to assure a more conducive learning environment in which social and emotional needs, as well as the academic needs, are attended to.

THE ROLE OF SCIENCE IN THE MIDDLE SCHOOL CURRICULUM

Examinations of surveys and other studies indicate that science is normally found as a part of the curriculum in each grade level and in all middle schools. Although there are some exceptions to the rule, science is usually a required subject, taken all year long, by all students. There is no question but that science has been, historically, and will continue to be, an integral component in the middle school curriculum. It seems that the point in question is not whether science is included in the middle school curriculum, but instead what is to be included in an appropriate science program at the middle school level, and, of equal importance, how it should be taught.

One answer may be in the current curricular approach. Unified approaches, for grades 7, 8, and 9, can be found in various schools and may possibly be the programs for the future. The existence of unified approaches is limited, however, partially by the fact that science education majors more often go the biology, chemistry, physics, or geology route rather than a broad field or science area approach. This is an influence of the secondary school. As more middle school teacher preparation programs are established in colleges, so will more middle school teachers be able to teach an integrated approach.

Unfortunately, the articulation between grades 6 and 7 appears to be very poor, and at times nonexistent. Methods may vary drastically and seem to depend heavily on the science teaching of individual teachers. Again, middle school teacher preparation programs will help close the gap and provide a better content and methodological preparation for fifth and sixth-grade teachers of science.

CONCLUSION

The growth of middle school education in the past two decades has been a phenomenon that has occurred because of the commitment and competence of educators who are concerned with providing the best educational experiences possible for early adolescent students. This growth pattern is not expected to decline in this decade, but instead it is anticipated that "new frontiers" will be opened as more is discovered concerning the unique learning habits of this age group. All who are directly involved in the planning of programs and educational experiences for middle school students will be challenged as these "new frontiers" open. Many alternatives are currently available and are being used in program development for middle schools. However, the foremost consideration must be to plan programs which will continue to meet the unique needs of the students in the middle grades.

Science educators, at all levels, stand to enhance the future development of middle school educational experiences for the students. By studying the most appropriate research findings, and using the most appropriate materials and teaching techniques, teachers of science at the middle school level will make the science classrooms "come alive" for their students. The challenge belongs to all of us; let us strive individually, as well as collectively, to develop the minds, and to provide positive direction to our most precious asset--our children. Their future is in our hands.

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CHAPTER II

CONTEMPORARY LIFE AS A SOURCE OF OBJECTIVES FOR MIDDLE SCHOOL SCIENCE

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A fellow science educator on the way home from a professional meeting recently stopped by for a chat. When asked for a reaction to the meeting, she quickly replied, "Most of the people there acted like they had been on Mars for the last 50 years!" And then, before she could expand on her answer, her departing flight was announced.

Are our science programs for students of middle school age 50 years behind the times? For those believing this is the case, what reasons can be given to support such a serious indictment? Basically, the charges can be grouped into two categories. First, there are those, including many science educators, scientists and laypersons, who have reservations about most of what we teach or the science curriculum. Second, there also is concern about how we teach middle school science or the instruction side of the coin.

A Model for Identifying Goals and Objectives

Chapters 2, 3, and 4 of this Yearbook focus on the sources of the educational goals and objectives. The sources examined include contemporary life, the discipline of science, and the learners themselves. These are the same three divisions used by Tyler (1949) and they also can be used in other curriculum development models. A diagram of Tyler's approach to the identification of goals and objectives is shown in Figure 1.

Examples of science objectives that might be identified using this model are as follows:

From Contemporary Life

--When voting for candidates and on referendums, the individual will be able to make intelligent decisions on science-related issues.

--As a potential parent, the individual is able to make appropriate decisions relative to health and medical problems.

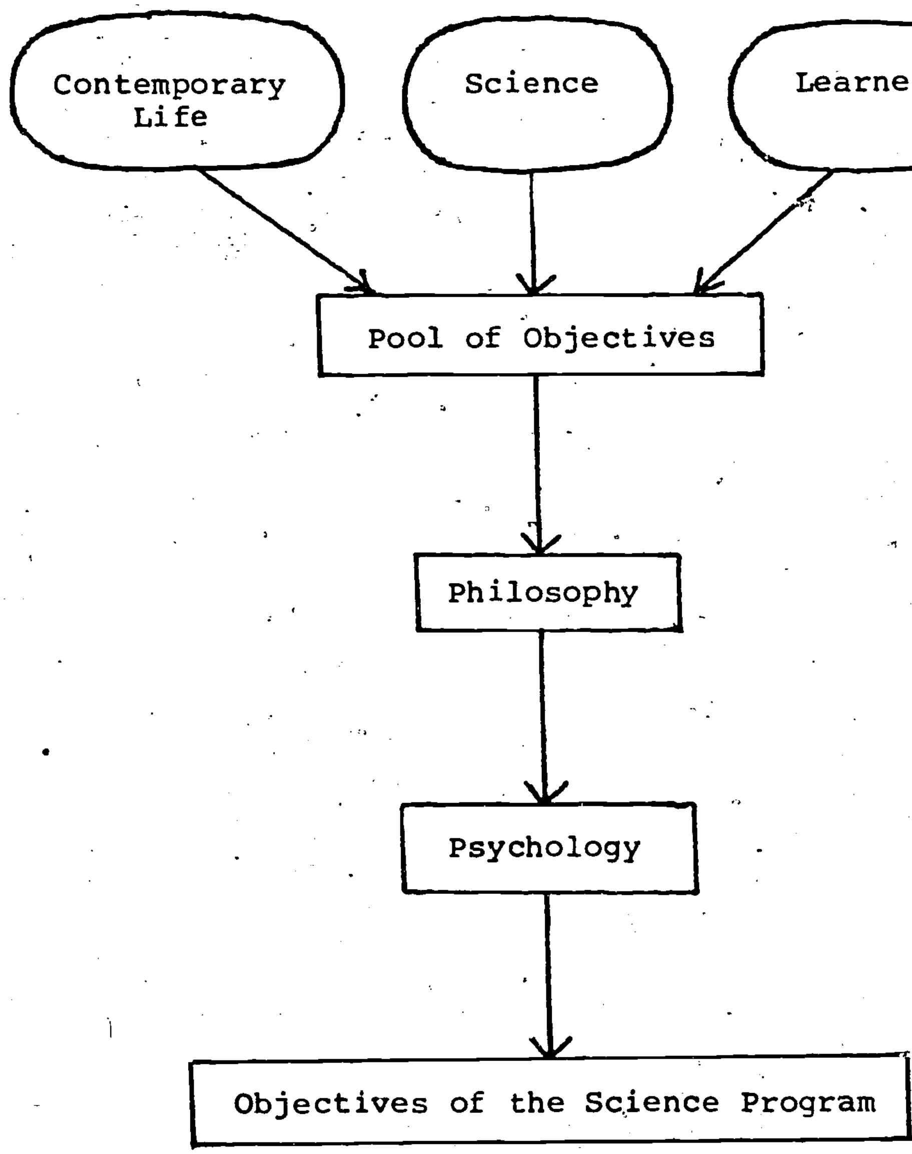

Figure 1. THE TYLER MODEL OF CURRICULUM DEVELOPMENT

From the Discipline of Science

--When given the reactants in a common chemical reaction, the individual can predict the products.

--When given the blood type of a patient, the individual can specify the type or types of blood that should be used in a transfusion.

From the Learners Themselves

--The individual understands the physical changes that occur during early adolescence and understands that all individuals don't develop in exactly the same way or at the same rate.

--The individual recognizes the symptoms of venereal disease.

Any conscientious application of the Tyler model usually results in more objectives than it is possible to achieve in one year or even in a K-12 science program. As a means of reducing the objectives identified to a manageable number and in order to remove these objectives that might be considered undesirable, the objectives are subjected to the "screens" or sieves of philosophy and psychology. The philosophy screen is used to sift out the most highly prized objectives from those judged to be of lesser value. Also, objectives that would not be acceptable to the school's various publics are removed. In like manner, the psychology screen is used to remove objectives. Examples of objectives removed might include those that take a very long time to achieve or ones that are almost impossible to attain with middle school students.

Advantages and Limitations of Using Contemporary Life as a Source of Objectives

Before undertaking an examination of contemporary life as a source of educational objectives, it will be helpful to review the two commonly used arguments for doing so:

> The first of these arguments is that because contemporary life is so complex and because life is continually changing, it is very necessary to focus educational efforts upon the critical aspects of this complex life and upon those aspects that are of importance today so that we do not waste the time of students in learning things that were important 50 years ago but no longer have significance at the same time that we are neglecting areas of life that are now important and for which the schools provide no preparation.

> A second argument for the study of contemporary life grows out of the findings relating to transfer of training. As long as educators believed that it was possible for a student to train his mind and the various faculties of the mind in general and that he could use these faculties under whatever conditions might be appropriate, there was less need for analyzing contemporary life to suggest objectives... Studies of transfer of training, however, indicated that the student was much more likely to apply his learning when he recognized the similarity between the situations encountered in life and the situations in which the learning took place. Furthermore, the student was more likely to perceive the similarity between the life situations and the learning situations when two conditions were met: (1) the life situations and the learning situations were obviously alike in many respects, and (2) the student was given practice in seeking illustrations in his life outside of school for the application of things learned in school. (Tyler, 1949, pp. 17-18)

Tyler recognizes that there are shortcomings to using contemporary life as a basis for the derivation of objectives and suggests how these criticisms can be met.

> One of the most frequent criticisms has been that the identification of contemporary activities does not in itself indicate their desirability. The finding, for example, that large numbers of people are engaged in certain activities does not, per se, indicate that these activities should be taught to students in the school. Some of these activities may be harmful and, in place of being taught in the school, some attention might need to be given to their elimination. The second type of criticism is the type made by essentialists who refer to studies of contemporary life as the cult of "presentism." These critics point out that because life is continually changing, preparing students to solve the problems of today will make them unable to deal with the problems they will encounter as adults because the problems will have changed. A third kind of criticism is that made by some progressives who point out that some of the critical problems of contemporary life and some of the common activities engaged in by adults are not in themselves interesting to children nor of concern to children, and to assume that they should become educational objectives for children of a given age neglects the importance of considering the children's interests and children's needs as a basis for deriving objectives.

These criticisms in the main apply to the derivation of objectives solely from studies of contemporary life. When objectives derived from studies of comtemporary life are checked against other sources and in terms of an acceptable educational philosophy, the first criticism is removed. When studies of contemporary life are used as a basis for indicating important areas that appear to have continuing importance, and when the studies of contemporary life suggest areas in which students can have opportunity to practice what they learn in school, and also when an effort is made to develop in students an intelligent understanding of the basic principles involved in these matters, the claim that such a procedure involves a worship of "presentism" is largely eliminated. Finally, if studies of contemporary life are used to indicate directions in which educational objectives may aim, while the choice of particular objectives for given children takes into account student interests and needs, these studies of contemporary life can be useful without violating relevant criteria of appropriateness for students of particular age levels. Hence, it is worthwhile to utilize data obtained from studies of contemporary life as one source for suggesting possible educational objectives. (Tyler, 1949, pp. 18-19)

Reminders for Curriculum Developers

Our own experience using the Tyler Model suggests that there are several things that should be kept in mind during the process of identifying objectives:

1) Many objectives do not originate from a single source, but can be derived from two or all three of the sources shown in Figure 1. For example, the objective dealing with venereal disease represents both a problem of society and a potential problem for middle school students, as well as being related to some important ideas in microbiology. Often objectives having more than one source, such as those dealing with science and society relationships, are ultimately judged to be more important than those that have a single source.

2) A mushrooming list of potential objectives can easily overwhelm even an experienced curriculum developer. Even though a deliberate attempt is made to identify only objectives for middle school science, in practice this turns out to be impossible. Many of the objectives identified

also will be claimed by elementary school science programs and by science courses in high school and post-secondary institutions. Also, the responsibility for the achievement of many of these objectives will be shared with mathematics, social studies, industrial arts, and other school subjects. And all too often we forget that students acquire much of their knowledge and attitudes from out-of-school experiences. Remembering that middle school science alone does not have to provide for all of a student's education should have a comforting effect on the curriculum developer. However, it also adds another responsibility--that of providing for articulation within a science program, coordination of goals among school subjects, and the development of a curriculum that reflects and builds on science-related experiences outside of the school.

3) Curriculum developers often begin by trying to answer the question posed in the title of Herbert Spencer's famous essay, "What Knowledge is of Most Worth?" Or, in more specific and more modern terms, "What is the best science education for today's youth?" The trouble with this approach is that most of us know the answer-scientific literacy!

We feel it is unreasonable to expect curriculum developers to give up all they know and feel about goals and to begin with a clean sheet of paper and a completely objective analysis of contemporary life, science, and middle school students. What is both reasonable and desirable, however, is for us to at least look at these three sources in the broad sense and then to examine each of the components of scientific literacy in terms of what we have found. To do otherwise is to espouse a litany without understanding the theology that led to its creation.

4) Tyler points out that in making studies of life outside the school, it is necessary to divide life into various phases in order to have manageable areas for investigation. Although most curriculum developers using the Tyler Model agree with this point, there is little agreement on what constitutes the phases of contemporary life that should be analyzed. We believe this disagreement illustrates an important characteristic of curriculum development that easily can be overlooked. Curriculum development is a creative process and, although models may be useful, there are no formulas or set of rules for its effective

execution. Individuals or curriculum committees must examine what they judge to be the most important characteristics of each of the sources of objectives.

In the remainder of this chapter we shall briefly describe some of the characteristics of contemporary life we feel should be considered in designing a science curriculum. In doing so we will focus mainly on contemporary life in terms of our nation and the world.

We Live in a Society That Can be Characterized by Its Values

The mere mention of the word "values" brings to mind topics such as abortion, evolution and creationism, and the humane treatment of animals. While these value-laden topics and other controversial topics must be addressed in doing curriculum development work, it is imperative that we also look at values and contemporary life in a broader context.

Democratic Values

Education in the United States is, and should be, different from education in many of the other countries of the world. Ours is a democracy and as such we have an obligation to all our citizens and expectations for each of them. Furthermore, certain ideals are embraced, as illustrated by the following list adapted from Alberty and Alberty (1962):

1) A democracy is a form of social organization which holds that the optimal development of each individual--of all individuals--is of highest good.

2) People can achieve their highest possible development only through acting in concert with their fellow citizens, each individual being sensitive to the effects of his or her acts on others.

3) The optimal development of all can be realized only to the extent that people have faith in intelligence as a method of solving individual and group problems. (p. 53)

The above statements support our efforts to provide for science education of all our citizens. More specifically, students in middle schools must receive the benefits of studying science and our society ultimately will benefit from their having done so. And this education must be provided not only because it helps them obtain jobs and thus reduce unemployment and a burden on the government, not only because it may reduce teenage pregnancies and the load on our social services agencies, and not only because reducing the use of illegal drugs may reduce the crime rate, but because it is the right thing to do and a necessary condition for claiming we hold democratic values to be of most worth.

At one time science courses for younger adolescents were the first step in a process that excluded, course by course, all but the most able. Although most of the students who managed to stay in school took high school biology, less than half of those completing biology enrolled in chemistry, and less than half of those taking chemistry elected physics. An equally serious problem was that those students who survived this curriculum most often were white males from economically advantaged homes.

The middle school science curriculum, because of the values held by our society, must be designed to provide for the science education of all our students--regardless of sex, race, or social and economic background. To do so will not easily be accomplished, nor is it easy to generate a list of science objectives in one, two, three order that clearly reflects the actual values of our society. The task, however, is not impossible, and one of our greatest advantages, as science educators, is the nature of the subject matter we teach.

A Marriage of Democratic Values and the Values Underlying Science

The Educational Policies Commission (1966), in its monograph Education and the Spirit of Science, identified seven values underlying science which they felt could be used to guide all educators in science and other subjects:

1) Longing to know and to understand
2) Questioning of all things
3) Search for data and their meaning
4) Demand for verification
5) Respect for logic
6) Consideration of premises
7) Consideration of consequences (p. 15)

After a discussion of each of these seven values, the authors of Education and the Spirit of Science conclude:

> Here then, is a group of values which schools can promote without doing violence to the dignity of the individual. Here are values which are not

intended to be accepted on the basis of external authority. On the contrary, they are themselves frankly intended to be challenged. The school here envisioned would have failed in the case of any student who has never questioned the desirability of these values. It would have failed in the case of any student who has never compared the various bases which different men deem sufficient for knowing or for acting. The view of teaching as the indoctrination of superior knowledge and wisdom here gives way to a concept of teaching as promotion of the development of the learner within.

In this way schools can be profoundly concerned with values and ethics in a manner fully consistent with the democratic belief in the dignity of the individual and with the scientific belief that no one--the school included--knows the final answers. (pp. 21-22)

The values of our society and of science are of such importance that they form the matrix for the remainder of our discussion of contemporary life. In our opinion, the powerful nature of these values suggests that they should comprise one of the major goals of middle school science.

We Live in a World of Science and Technology

Science educators are acutely aware of the effects of science and technology on our lives. Each of us has a favorite example of the knowledge explosion in science, the effects of scientific thinking on human conduct, and the implications of science and technology for work, leisure, and world peace.

The authors of Education and the Spirit of Science, in the introduction to the monograph published 15 years ago and which still conveys an important message for science education, succinctly summarize several of the important characteristics of contemporary life in a world of science and technology:

In the modern world the approach of rational inquiry--the mode of thought which underlies science and technology--is spreading rapidly and, in the process, is changing the world in profound ways. This mode of thought is not new in itself; it has engaged the efforts of some of the best minds for centuries. The scale of today's involvement with it, however, is new. For the first time, it is the source of livelihood for a considerable number of people, most of them engaged in the areas of science and technology. These people have presented the world with a constant progression of phenomenal successes; and, understandably, the type of inquiry which accounts for those successes is rewarded with increasing prestige. The spirit of rational inquiry, driven by a belief in its efficacy and by restless curiosity, is therefore commonly called the <u>spirit of science</u>.

The most commonly recognized manifestations of the scientific and technological revolution are the material ones. The physical accoutrements and institutions of the advanced societies have been and continue to be altered; the living standards of many peoples have risen. But much more is changed than the material conditions of life. Modern industrialized societies possess basic elements which make them unique in history. Old routines and time-honored patterns of existence have been destroyed or profoundly changed. Economic systems are modified at an accelerating rate. The methods and results of science introduce a widespread criticism and willing ness to forego traditional ways in art and philosophy and they both force and enable theologians to consider new ways of defending the validity and relevance of faith.

In addition, the scientific and technological revolution affects the very texture of thinking of the common man. The gulf in spirit between this age and all previous ages is perhaps more vast than the gulf in external appearances. New or modified values and attitudes, combining to produce a new perspective on life, are gaining currency in the industrialized countries. The spread of technology is accompanied by an increasing respect for utility, efficiency, and practical results and an increasing interdependence of individuals. The spread of science promotes respect for the role of reason in human affairs by demonstrating the power of the mind when used in accordance with the spirit of science. There is a tendency to be suspicious of absolutes, a respect for tentativeness, a kind of working skepticism. Science poses a clear challenge to pretensions of absolute certainty. It promotes respect for intellectual flexibility and creativity, for the ability to revise or discard old hypotheses and to form and substantiate new ones. There is also a tendency to see the world in an evolutionary frame of reference, to recognize that what exists now may not have existed in the past and that all things are in a process of becoming. (pp. 1-4)

More Thoughts for Curriculum Developers

In examining the effects of science and technology on our lives and in our search for educational objectives that encompass this phase of contemporary life, we believe it important to continuously remind ourselves of the following:

1) Perhaps the oldest students in a middle school in 1981 are 16 years of age; thus, they were born in 1965 and have little recollection of national and world events before 1970. This is the generation that has known color television, satellite communications, and manned flights to the moon. Few have suffered the pain of crippling and killing diseases such as polio, and a majority in this country have enjoyed the comforts of a standard of living unsurpassed in the history of civilization.

   Attempts to teach them about life in earlier times often results in their responding with humorous accounts of how their parents, grandparents, and teacher lived in "olden times." Young people probably always have been characterized as the "now generation." But rather than condemn them for their lack of insight and appreciation of science and technology, it is our responsibility as science educators to design curricula that help them understand the many roles science and technology have played.

2) Middle school students are not the only ones who show apathy for the roles and contributions of science and technology. Adults also take for granted many of the same things we chastise young people for not appreciating. Also, there is a growing awareness that not all the products of science and technology are necessarily beneficial nor that they will be utilized in acceptable ways. In terms of many issues facing the world--population, environment, peace--the debate rages on about whether science and technology are "part of the problem or part of the solution."

We Live in a World of Rapid Change

A major characteristic of any society is the extent to which change is experienced within. Over the past few hundred years Western cultures have undergone more rapid change than have Eastern cultures. Rate of change is influenced by religious beliefs, forms of government, economic systems, cultural values, education, and by the degree to which science and technology have permeated the society.

In addition to the amount of change that occurs within a society, another important aspect is how this change is viewed. Some individuals view change as primarily cyclic in nature, with variations emerging that gradually return to the former state. Others view change in a linear fashion. Of these, some view change as progressive and some view it as regressive. The rate of change within a society is significant, in part, by the amount of actual newness that is generated, and, in part, by the way it is received emotionally by the people.

Measures of Change

Herbert Spencer (Andreski, 1969) was one of the first philosophers to discuss social change in evolutionary terms. Drawing from his biological knowledge, he viewed society as an organism evolving from indefinite, incoherent homogeneity to definite, coherent heterogeneity. It was Spencer, by the way, not Darwin, who coined the phrase "survival of the fittest" and who applied it to humans rather than just to lower animals (Spencer, 1874).

In any event, our society in many ways is becoming more heterogeneous and at the same time more pluralistic. As stated, this is the natural route of evolution. But in other ways the world is becoming more homogeneous. Television, printed materials, and other media are spreading quickly many things that formerly remained isolated and discrete in the various regions of our planet. So, while society moves toward more complexity and diversity, a need arises for common themes that will bring all of this together.

With social change has also come increased population mobility. Today the average American moves every five years and it is rare to find adults who live in the same town in which they were born. This means that fewer people have a "home town," and family roots and ties are not as deep as they once were.

Population mobility has significantly affected the family unit in our country. Youngsters today are not as close to their grandparents, uncles, aunts, and cousins as they once were. Friendships today are formed more on a basis of common interest and less on a basis of "blood relationships." With more than 50 percent of today's mothers of school-age children working, the nature of the family is changing dramatically. This, in combination with the fact that today's divorce rate is the highest ever, has produced an abundance of single-parent families. Teachers in our schools can no longer assume that the majority of their students receive attention at home from both a mother and father.

The privacy of the home has also diminished. What was once the domain of the parents is now shared by others outside the family--physicians, social workers, fast-food cooks, and teachers. As Christopher Lasch (1977) recently observed, while the outside world has become increasingly complex and hostile humans look increasingly to the family as the last refuge. But the family often is not there to provide this solace. It is clear that the family, long considered to be the basic unit of our society, is undergoing stresses and strains that will influence the nature of our existence for years to come.

Another striking change in our society is that it is, collectively speaking, becoming older. With lower birth rates and increased longevity, we are moving from the youth-centered culture of the sixties and seventies to a strikingly older and more mature society in the eighties and nineties. So, while the rate of change in this country during the last several decades has been rapid compared to that of other countries, it is likely that this rate will become slower during the next few decades. As Alvin Toffler (1970) has suggested, we may start saying "no" increasingly often to many of the technologies that in the past have roared down upon us in an unchecked, uncontrolled manner.

How Social Change Influences the Middle School Science Curriculum

Most educators, in fact most citizens of this country, accept the fact that our society has experienced an unprecedented rate of change. One can merely look around and count the many things that now play an important part in our lives that were not in existence at the turn of this century. The automobile, electricity, the telephone, air conditioning, the hand-held calculator, and, more recently, the microcomputer, are prime examples of technological advances that have individually impacted on the way we live, think, and plan for the future. Each of these technologies, along with breakthroughs in medicine, psychology, and sociology, has brought about changes in religious beliefs, customs, and social values. These phenomena have implications for change in the middle school science curriculum in at least four broad areas.

1) With change so rampant, it will be increasingly difficult for the average citizen to keep up with all the new information that will be generated in the future. Yet, while the facts will be changing rapidly, the major paradigms of science will not. Basic laws that undergird our understanding of the physical world have not undergone revolutionary

change since the days of Galileo, Copernicus, Newton, and, more recently, Einstein. Likewise, the tenets of Darwin and Mendel form the basis for our understanding of biological change and not since Watson and Crick in the 1950s have we truly witnessed a scientific revolution. Most young people in our society do not study science in any appreciable, formal sense until they reach middle school. Many do not take additional courses beyond the tenth grade of high school. A major imperative of science education in the middle years must be, therefore, to give students a framework which they can use to interpret and understand the many facts and applications of science that will come their way throughout the rest of their lives.

2) The processes and methods of science should be stressed so that students will have a foundation on which to face the undreamed-of problems of the next century. While the circumstances will change and the contexts will be radically different, deviations from the methods used for problem solving and rational thinking today among humans are likely to occur much more slowly. While Plato and Aristotle would find today's world strikingly different, their ability to think in a logical manner would still be a refreshing and useful tool for survival. Teaching today's middle school science students to properly use scientific methodology is one of the best ways to hedge against a future that we cannot clearly envision or predict.

3) An important aspect of middle school science should be the study of interrelationships that exist between science and technology. In the past two decades there has arisen increased skepticism and fear of science. What has not been taught in our schools, and what is not well understood by many people, is that many of our so-called "science problems" are due to irresponsible decisions of individuals, businesses, industry, and government. As pointed out earlier, Toffler has warned us that continuing to say "yes" to every technology at our disposal will unquestionably lead to doom. We must begin to say no to overpowered automobile engines, unlimited nuclear power, indiscriminant use of medication, and food substitutes with little or no nutritional value. We must apply carefully and wisely what we know about genetic engineering, artificial insemination,

birth control, and euthenics. And we must say yes to energy-efficient buildings, laws that protect our endangered species, and systems for recycling many of our limited resources. It is human beings who have discovered science. It is also humans who have turned scientific understanding into high technology. In the future it will be humans who determine whether or not a rational and balanced world will come from all of this.

4) Rapid change in our society increases the need for teaching scientific values in our schools. Haney (1964) has proposed that the following represent important values in the development of scientific attitudes: curiosity, rationality, open-mindedness, critical mindedness, objectivity and intellectual honesty, willingness to suspend judgment, humility, and reverence for life.

Sociologist Bernard Barber (1961) has proposed that before science can develop and grow optimally as an enterprise within a society, five cultural values must be endemic. These are rationality, utilitarianism, universalism, individualism, and progress and meliorism. If one accepts both Haney's and Barber's lists of values as antecedents to the scientific enterprise, it becomes evident that the young people of today, in order to cope with the fast-moving changes of today and tomorrow, will have to acquire some important affective tools. To be intelligent consumers of science all citizens should respect truth, demand logic, maintain critical mindedness, and possess, perhaps above all, a tolerance for alternative viewpoints. These value systems are a part of the interests, beliefs, and attitudes of younger students and should be important goals of all middle school science programs.

We Live in a World That is Increasingly Interdependent: Problems and Issues for Future Consideration

While our society continues to evolve toward more complexity, greater specialization, and increased pluralism, our relationship with other countries becomes one of increased interdependence. In the past, Americans have constituted approximately 6 percent of the world's population but have managed, by most estimates, to control roughly a third of the resources and energy in the world. During the robust growth period of the first part of this century, competition, capitalism, and imperialism were the modus operandi that have made this and other developing countries flourish. Today, however, food supplies and energy resources are becoming critical and the threat of foreign intervention in the Arabian Peninsula threatens not only the United States but also the rest of the free world. Furthermore, with several countries now capable of conducting sophisticated nuclear warfare, there is a need for parity and cooperation among world leaders.

It is obvious that the people of this country will have to use less resources per capita in the future. The Global 2000 Report, issued by the Department of State under the Carter Administration on July 24, 1980, states: "If present trends continue, the world in 2000 will be more crowded, more polluted, less stable ecologically, and more vulnerable to disruption than the world we live in now....Despite greater material output, the world's people will be poorer in many ways than they are today" (The Global 2000 Report to the President, Volume 1, p. 1). The descriptions of the world situation in population, food, fisheries, forests, water and nonfuel minerals, and energy is based on data presented in the Global 2000 Report.

Population

The world's population in 1975 was approximately 4.1 billion. Projections are that the world population in 2000 will be 6.35 billion, or an increase of 55 percent in 25 years. Of this growth, 92 percent will occur in the less developed countries of the world. Of the 6.35 billion people in 2000, 5 billion will live in the less developed countries. Table 1 contains population projections for the world.

Lesser developed countries (LDCs) also will experience dramatic movements of rural populations to cities. By 2000, the population of Mexico City is projected to be more than 30 million, roughly three times the present population of greater New York City. Table 2 displays present and projected populations of 12 LDC cities.

TABLE 2

ESTIMATES AND ROUGH PROJECTIONS OF SELECTED URBAN AGGLOMERATIONS IN DEVELOPING COUNTRIES

	---------Millions of Persons--------			
	1960	1970	1975	2000
Calcutta	5.5	6.9	8.1	19.7
Mexico City	4.9	8.6	10.9	31.6
Greater Bombay	4.1	5.8	7.1	19.1
Greater Cairo	3.7	5.7	6.9	16.4
Jakarta	2.7	4.3	5.6	16.9
Seoul	2.4	5.4	7.3	18.7
Delhi	2.3	3.5	4.5	13.2
Manila	2.2	3.5	4.4	12.7
Tehran	1.9	3.4	4.4	13.8
Karachi	1.8	3.3	4.5	15.9
Bogota	1.7	2.6	3.4	9.5
Lagos	0.8	1.4	2.1	9.4

Source: Global 2000 Technical Report, Table 13-9.

Food

In 1970, one hectare of arable land supported an average of 2.6 persons. By the year 2000, one hectare will have to support four persons. Land under cultivation is expected to increase only by 4 percent. Increases in food production will have to come from yield-enhancing, energy-intensive technologies, such as those involving the use of fertilizers, pesticides, herbicides, and irrigation. However, food production is not likely to increase fast enough to meet rising demands unless more products made from petroleum are used. This increased dependence on petroleum has direct implications for the cost of food. It is projected that the real price of food will almost double by 2000. Actually, projections are that food supplies will increase slightly faster than population growth but that rising costs will result in many LDCs having less food on a per capita basis.

Fisheries

While the world's fish supply has been looked upon as a means for counterbalancing food shortages, world harvest of this resource is expected to rise little, if any, by the year 2000. While the projected fish supply holds little promise for solving the world's calorie needs, food from the sea is a good supply of protein. The 70 million metric tons of fish available in 1975 are roughly equivalent to 14 million metric tons of protein. This is enough to supply 27 percent of the minimum protein requirements of 4 billion people. Statistics for 1978 show a world catch of 72.4 million metric tons; yet, since more than one-third of the fish harvest is used for animal food, it would take a hypothetical catch of 115 million metric tons to supply 27 percent of the protein needs of the projected 6.35 billion people in 2000.

Forests

If present trends continue, commercially available wood in LDCs will decline 40 percent by 2000. Table 3 shows estimates of world forest resources for 1978 and 2000.

Deforestation is projected to continue until around 2020. Total world forest area is expected to stabilize at about 1.8 billion hectares. In industrialized nations, wood shortages are expected to be disruptive but not catastrophic. But in LDCs, 90 percent of wood consumption goes for cooking and heating. Sawn lumber, wood panels, paper, and wood-based chemicals will be increasingly short in supply in these countries. Again, the need for fuelwood in the future will be tied directly to the amount of petroleum that is available on the world market.

TABLE 3

ESTIMATES OF WORLD FOREST RESOURCES, 1978 AND 2000

	Closed Forest* (millions of hectares)		Growing Stock (billions M^3 overbark)	
	1978	2000	1978	2000
U.S.S.R.	785	775	79	77
Europe	140	150	15	13
North America	470	464	58	55
Japan, Australia, New Zealand	69	68	4	4
Subtotal	1,464	1,457	156	149
Latin America	550	329	94	54
Africa	188	150	39	31
Asia and Pacific LDCs	361	181	38	19
Subtotal (LDCs)	1,099	660	171	104
Total (world)	2,563	2,117	327	253
			Growing Stock per Capita (M^3 biomass)	
Industrial countries			142	114
LDC's			57	21
Global			76	40

*Closed forests are relatively dense and productive forests. They are defined variously in different parts of the world. For further details, see Global 2000 Technical Report, footnote, p. 117.

Source: Global 2000 Technical Report, Table 13-29.

Water and Nonfuel Minerals

Increases of approximately 200-300 percent in world water withdrawals are expected during the period between 1975 and 2000. Increase in the amount of irrigation will account for the largest portion of this increase. In addition to water shortages in many areas, water quality in general will likely be lower by 2000. Africa, South Asia, the Middle East, and Latin America are areas where freshwater will continue to be in short supply.

Both the demand for and use of nonfuel minerals such as phosphate rock, aluminum, copper, and iron ore will continue to rise through the remainder of this century. The one-fourth of the world comprising the industrial countries is projected to consume more than three-fourths of the world's nonfuel minerals.

Energy

Americans are better informed about energy shortages than they are about the supply and demand for other resources. There is general agreement that a world transition away from petroleum dependence is imperative, but there is uncertainty about how this will occur. The U.S. Department of Energy is not able to make projections concerning energy sources and demands beyond 1990. World energy demand from 1975 to 1990 is expected to increase 58 percent. Oil will continue to be the world's leading energy source, providing about 46-47 percent of the total through 1990. Nuclear and some hydro sources of energy are expected to increase most rapidly. In addition to oil, demands for natural gas (43 percent) and coal (13 percent) will continue to increase. One thing suggested by the Global 2000 Report is that there is considerable potential for reductions in energy consumption. By 2000, U.S. per capita energy consumption is projected to be approximately 422 million Btus per year. In LDCs it is projected at only 14 million Btus.

Fuelwood, the poor person's oil, is also expected to become more scarce. In some of the arid regions of Africa fuelwood gathering requires as much as 360 person-days of work per household each year. Again, at this point, it is extremely difficult to assess both wood costs and oil costs. The Department of Energy projected the cost of oil per barrel in 1977 to be $36 by 1995. The current projection (1979) is that a barrel of oil will cost $40 in 1995, a 10 percent increase in two years. While coal and nuclear energy will help offset some of the increase in demand, energy supply and demand ratios are likely to remain critical for the rest of this century.

In order to share with the readers of this yearbook a "feel" for "entering the twenty-first century," the summary of the Global 2000 Report is included as an appendix to this chapter.

Summary

Middle schools and middle school science programs have not appeared through an act of spontaneous generation, but, like other educational institutions and practices, have ancestors. In many cases these ancestors were junior high schools and discipline-centered science courses. Because of our heritage, we should not expect an examination of contemporary life, science, and learners to necessarily result in revolutionary curriculum changes. Furthermore, not all we have been teaching has been made obsolete by the rapid changes that are occurring.

But we hope two things will happen. First, schools, agencies, and other groups will continue to engage in the design of new curricula, which represent objectives beyond those presently in the science curricula and which consist of new groupings of objectives. Second, and as a minimum, our present programs should be taught so they better reflect contemporary life, science, and the nature of learning. If our middle school science curriculum is to prepare students for adult life in the 21st Century, which will be characterized by some of the problems briefly discussed in this chapter, then we must continue to refine, and reflect on, our goals and objectives.

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CHAPTER II APPENDIX

ENTERING THE TWENTY-FIRST CENTURY

The preceding sections have presented individually the many projections made by U.S. government agencies for the Global 2000 Study. How are these projections to be interpreted collectively? What do they imply about the world's entry into the twenty-first century?

The world in 2000 will be different from the world today in important ways. There will be more people. For every two persons on the earth in 1975 there will be three in 2000. The number of poor will have increased. Four-fifths of the world's population will live in less developed countries. Furthermore, in terms of persons per year added to the world, population growth will be 40 percent higher in 2000 than in 1975.

The gap between the richest and the poorest will have increased. By every measure of material welfare the study provides--per capita GNP and consumption of food, energy, and minerals--the gap will widen. For example, the gap between the GNP per capita in the LDCs and the industrialized countries is projected to grow from about $4,000 in 1975 to about $7,900 in 2000. Great disparities within countries are also expected to continue.

There will be fewer resources to go around. While on a worldwide average there was about four-tenths of a hectare of arable land per person in 1975, there will be only about one-quarter hectare per person in 2000. By 2000 nearly 1,000 billion barrels of the world's total original petroleum resource of approximately 2,000 billion barrels will have been consumed. Over just the 1975-2000 period, the world's remaining petroleum resources per capita can be expected to decline by at least 50 percent. Over the same period, world per capita water supplies will decline by 35 percent because of greater population alone; increasing competing demands will put further pressure on available water supplies. The world's per capita growing stock of wood is projected to be 47 percent lower in 2000 than in 1978.

The environment will have lost important life-supporting capabilities. By 2000, 40 percent of the forests still remaining in the LDCs in 1978 will have been razed. The atmospheric concentration of carbon dioxide will be nearly one-third higher than pre-industrial levels. Soil erosion will have removed, on the average, several inches of soil from croplands all over the world. Desertification (including salinization) may have claimed a significant fraction of the world's rangeland and cropland. Over little more than two decades, 15-20 percent of the earth's total species of plants and animals will have become extinct--a loss of at least 500,000 species.

Prices will be higher. The price of many of the most vital resources is projected to rise in real terms; that is, over and above inflation. In order to meet projected demand, a 100 percent increase in the real price of food will be required. To keep energy demand in line with anticipated supplies, the real price of energy is assumed to rise more than 150 percent over the 1975-2000 period. Supplies of water, agricultural land, forest products, and many traditional marine fish species are projected to decline relative to growing demand at current prices, which suggests that real price rises will occur in these sectors too. Collectively, the projections suggest that resource-based inflationary pressures will continue and intensify, especially in nations that are poor in resources or are rapidly depleting their resources.

The world will be more vulnerable both to natural disaster and to disruptions from human causes. Most nations are likely to be still more dependent on foreign sources of energy in 2000 than they are today. Food production will be more vulnerable to disruptions of fossil fuel energy supplies and to weather fluctuations as cultivation expands to more marginal areas. The loss of diverse germ plasm in local strains and wild progenitors of food crops, together with the increase of monoculture, could lead to greater risks of massive crop failures. Larger numbers of people will be vulnerable to higher food prices or even famine when adverse weather occurs. The world will be more vulnerable to the disruptive effects of war. The tensions that could lead to war will have multiplied. The potential for conflict over fresh water alone is underscored by the fact that out of 200 of the world's major river basins, 148 are shared by two countries. Long-standing conflicts over shared rivers such as the Plata (Brazil, Argentina), Euphrates (Syria, Iraq), or Ganges (Bangladesh, India) could easily intensify.

Finally, it must be emphasized that if public policy continues generally unchanged, the world will be different as a result of lost opportunities. The adverse effects of many of the trends discussed in this study will not be fully evident until 2000 or later; yet the actions that are necessary to change the trends cannot be postponed without foreclosing important options. The opportunity to stabilize the world's population below 10 billion, for example, is slipping away; Robert McNamara, President of the World Bank, has noted that for every decade of delay in reaching replacement fertility, the world's ultimately stabilized population will be about 11 percent greater. Similar losses of opportunity accompany delayed perceptions or action in other areas. If energy policies and decisions are based on yesterday's (or even today's) oil prices, the opportunity to wisely invest scarce capital resources will be lost as a consequence of undervaluing conservation and efficiency. If agricultural research continues to focus on increasing yields through practices that are highly energy-intensive, both energy resources and the time needed to develop alternative practices will be lost.

The full effects of rising concentrations of carbon dioxide, depletion of stratospheric ozone, deterioration of soils, increasing introduction of complex persistent toxic chemicals into the environment, and massive extinction of species may not occur until well after 2000. Yet once such global environmental problems are in motion they are very difficult to reverse. In fact, few if any of the problems addressed in the Global 2000 Study are amenable to quick technological or policy fixes; rather, they are inextricably mixed with the world's most perplexing social and economic problems.

Perhaps the most troubling problems are those in which population growth and poverty lead to serious long-term declines in the productivity of renewable natural resource systems. In some areas the capacity of renewable resource systems to support human populations is already being seriously damaged by efforts of present populations to meet desperate immediate needs, and the damage threatens to become worse.

Examples of serious deterioration of the earth's most basic resources can already be found today in scattered places in all nations, including the industrialized countries and the better-endowed LDCs. For instance, erosion of agricultural soil and salinization of highly productive irrigated farmland is increasingly evident in the United States; and extensive deforestation, with more or less permanent soil degradation, has occurred in Brazil, Venezuela, and Colombia. But problems related to the decline of the earth's carrying capacity are most immediate, severe, and tragic in those regions of the earth containing the poorest LDCs.

Sub-Saharan Africa faces the problem of exhaustion of its resource base in an acute form. Many causes and effects have come together there to produce excessive demands on the environment, leading to expansion of the desert. Overgrazing, fuelwood gathering, and destructive cropping practices are the principal immediate causes of a series of transitions from open woodland, to scrub, to fragile semiarid range, to worthless weeds and bare earth. Matters are made worse when people are forced by scarcity of fuelwood to burn animal dung and crop wastes. The soil, deprived of organic matter, loses fertility and the ability to hold water--and the desert expands. In Bangladesh, Pakistan, and large parts of India, efforts by growing numbers of people to meet their basic needs are damaging the very cropland, pasture, forests, and water supplies on which they must depend for a livelihood. To restore the lands and soils would require decades--if not centuries--after the existing pressures on the land have diminished. But the pressures are growing, not diminishing.

There are no quick or easy solutions, particularly in those regions where population pressure is already leading to a reduction of the carrying capacity of the land. In such regions a complex of social and economic factors (including very low incomes, inequitable land tenure, limited or no educational opportunities, a lack of nonagricultural jobs, and economic pressures toward higher fertility) underlies the decline in the land's carrying capacity. Furthermore, it is generally believed that social and economic conditions must improve before fertility levels will decline to replacement levels. Thus a vicious circle of causality may be at work. Environmental deterioration caused by large population creates living conditions that make reductions in fertility difficult to achieve; all the while, continuing population growth increases further the pressures on the environment and land.

The declines in carrying capacity already being observed in scattered areas around the world point to a phenomenon that could easily be much more widespread by 2000. In fact, the best evidence now available--even allowing for the many beneficial effects of technological developments and adoptions--suggests that by 2000 the world's human population may be within only a few generations of reaching the entire planet's carrying capacity.

The Global 2000 Study does not estimate the earth's carrying capacity, but it does provide a basis for evaluating an earlier estimate published in the U.S. National Academy of Sciences' report, Resources and Man. In this 1969 report, the Academy concluded that a world population of 10 billion "is close to (if not above) the maximum that an intensively managed world might hope to support with some degree of comfort and individual choice." The Academy also concluded that even with the sacrifice of individual freedom and choice, and even with chronic near starvation for the great majority, the human population of the world is unlikely to ever exceed 30 billion.

Nothing in the Global 2000 Study counters the Academy's conclusions. If anything, data gathered over the past decade suggest the Academy may have underestimated the extent of some problems, especially deforestation and the loss and deterioration of soils.

At present and projected growth rates, the world's population would rapidly approach the Academy's figures. If the fertility and mortality rates projected for 2000 were to continue unchanged into the twenty-first century, the world's population would reach 10 billion by 2030. Thus anyone with a present life expectancy of an additional 50 years could expect to see the world population reach 10 billion. This same rate of growth would produce a population of nearly 30 billion before the end of the twenty-first century.

Here it must be emphasized that, unlike most of the Global 2000 Study projections, the population projections assume extensive policy changes and developments to reduce fertility rates. Without the assumed policy changes, the projected rate of population growth would be still more rapid.

Unfortunately population growth may be slowed for reasons other than declining birth rates. As the world's populations exceed and reduce the land's carrying capacity in widening areas, the trends of the last century or two toward improved health and longer life may come to a halt. Hunger and disease may claim more lives--especially lives of babies and young children. More of those surviving infancy may be mentally and physically handicapped by childhood malnutrition.

The time for action to prevent this outcome is running out. Unless nations collectively and individually take bold and imaginative steps toward improved social and economic conditions, reduced fertility, better management of resources, and protection of the environment, the world must expect a troubled entry into the twenty-first century.

CHAPTER III

SUBJECT MATTER SPECIALISTS AS A SOURCE OF EDUCATIONAL OBJECTIVES FOR MIDDLE SCHOOL SCIENCE

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GOALS FOR JUNIOR HIGH SCHOOL SCIENCE

What science should be taught to all children in grades 7-9? This paper will attempt to answer that question in terms of the scientists and the science educators, not of the psychologists, physiologists, or sociologists. In such an attempt there is triple jeopardy in both theory and practice.

For the last decade curriculum study has been struggling under the authoritative pronouncement that "The field of curriculum is moribund. It is unable, by its present methods and principles, to continue its work and contribute significantly to the advancement of education" (Schwab, 1969, p. 1). Add to this the more recent comments that also call for a paradigm shift in science education, a search for meta-analysis, a "theory of theories" (Hurd, 1980):

> The characteristic practice in science education research has been a constant effort to add new data to old problems in contrast to seeking new methods of dealing with old problems or perceiving new problems. One reason new problems are not recognized is a lack of historical perspective within the discipline, and finally, a fourth is the absence of a normative rationale for science education; thus there is no way to identify next steps. (p. 33)

To this we add the problems of defining the junior high school or the middle school, a stepchild in education, always last or left out, always sandwiched between elementary school and senior high school. Triple jeopardy in theory.

The practical problems are of even greater concern. After two decades of involvement with "new science curricula devoted to inquiry approaches" the NSF Summary of 1980 points out in statement after statement that the text and the teacher are still the dual foci for the science classroom. Add to these two problems the reflections of the National School Boards Association on the very last six pages of this summary (NSF, 1980, pp. 206-211) of more than two thousand pages.

After noting that the NSF report was too harsh, it mentions what its 14 school board members saw as the key obstacles to meaningful curriculum change:

> Lack of school board initiative,
>
> Impact of back-to-basics movement,
>
> Insufficient funds for materials and supplies,
>
> Inadequate inservice training,
>
> The impact of collective bargaining, and
>
> Lack of public confidence in the schools. (p. 208)

On the next page are listed six Trends to Watch for in Curriculum Planning:

> Continuing enrollment declines (less demand for new development),
>
> The "tax revolt" (less capital for curriculum),
>
> Collective bargaining (more dollars into salaries),
>
> Energy crisis (more dollars into fuel),
>
> Ethnic awareness (entering texts and programs),
>
> Changing structure of the family (day care centers, etc. in schools). (p. 209)

Finally, after it is mentioned that one expert believes that in ten years only one-half the funds currently being spent for education will be available, we are told that schools are so labor intensive now that 85 to 90 percent of the funds are "earmarked for personnel costs." Further, that salvation may come if schools could become more "capital intensive," making greater use of technology and media for courses "involving training, such as mathematics and reading."

This article is mentioned at the beginning because it is so challenging to an academic, yet so basic to our discussion of objectives in science. In the usual dozen or so periodicals in science education that must be covered to keep up on the field, statements about unions, taxes, and school boards are rarely if ever encountered. As we attempt to consider the goals for junior high school science in the '80s, we can easily drift up to Cloud Nine. With the help of the previous considerations at Ground Zero, maybe the possible can be more reasonably approached.

a scientific picture of the world (p. 29). For example, health as an objective may be considered at either the personal or community level where more specific topics such as disease and its prevention would be further subdivided into appropriate goals of knowledge, skills, and attitudes.

A second kind of list would concern the particular contributions that a subject can make to other large educational functions. Tyler mentions the Report of the Committee on Science in General Education as a good example of this where "In personal living, for example, suggestions are made as to ways in which science can help to contribute to personal health, to the need for self assurance, to a satisfying world picture, to a wide range of personal interests, and to aesthetic satisfaction" (p. 31). Further examples are then given regarding social relations, economic relations, career planning, etc. Finally, Tyler tells us to make lists from such reports that apply to our area of concern--here the junior high school.

THE GENERAL PROBLEM

The problem we face at the junior high school level is part of the much larger one of bringing individuals and society together, whether the word we use is educate, lead, mold, unite, etc. In all areas the pressures faced by individuals in society and the society itself as a multifaceted totality are naturally reflected in the education patterns that are set up to join them. In science such patterns are reflected in four yearbooks of the National Society for the Study of Education: Numbers 3, 31, 46, and 59. The earlier volumes show the schools emphasizing nature study at the turn of the century as large numbers of people moved into the cities, then trying to integrate this nature study at the elementary school level with the individual disciplines of the secondary schools. More and more the social implications of science were stressed as well as its part in an education that would continue for a lifetime.

The later yearbooks took a closer look at the "maturity of students" in designing science curricula. By 1960 the question was asked about proper objectives for a science course within a general education framework--at both college and junior high level. At the college level a large concern was whether the course should be a survey type or an in-depth, technically detailed case study, whether in an historical framework or from original and contemporary scientific research. For grades 7 and 8 there was proposed a general science course that would try to build on the students' previous elementary training. It would include material from all of the sciences and be organized around broad areas of important human activities. The ninth-grade course would be similar if previous training had been weak. Otherwise, it would be either an introductory biological or physical science course aimed at introducing the student to understanding scientific methods, the unifying science concepts, and some applications. By this time the science community was finally becoming aware of the reason for the creation of junior high schools early in this century. These years were recognized as special years of student growth and needed to be considered in a special way.

But the problems and biases against junior high schools are still with us. When Sputnik arrived in 1957, there was a rush both in the United States and in Britain to improve scientific training and "catch up with Russia." We needed a much broader base from which to draw scientists, so specialists in science were gathered together to produce science courses for the secondary school. Then elementary programs were begun--to foster the spirit of inquiry and discovery inherent in the scientific method. Finally, junior high courses began to be developed. Often they were in one discipline for the ninth grade or they were a patchwork of course parts from several disciplines with no integration and were called general science.

This is quite natural because such material was readily available, thus easier to use. But what had been gradually asked for over the last few decades was more than that. It was for courses that joined the elementary school curriculum to that of the secondary school curriculum thus providing a continuous life-long learning experience. It was for a science course that was more than a patchwork quilt of various sciences, one that was truly interdisciplinary, joining previously individual disciplines in some rational structure based on common interests, aims, methods, conceptual schemes, etc. Scientists and science educators responded, and such courses were developed, tested and evaluated both here and abroad. They will be discussed later, after the problem is further defined and limited.

SOME DEFINITIONS AND LIMITATIONS

Junior High School --Grades 7-9 (students aged 12-15) wherever they happen to occur.

Objectives --Broad goals and aims rather than narrow behavioristic ones. The latter (observation, classification, description, etc.) are assumed in the former.

Knowledge, Skills, Attitudes --Used broadly so that skills may be not only psychomotor but also cognitive (as "ability to think critically" etc.), and attitudes would include interests, appreciation, etc.

Science --An interconnected series of concepts and conceptual schemes that have developed as a result of experimentation and observation and are fruitful of further experimentation and observations (Conant, 1951, p. 25).

Interdisciplinary --A union of two or more separate disciplines, not merely randomly nor sequentially, but in a rational structure based on common knowledge, interests, aims, methods, conceptual schemes, etc.

Nonscientist --One whose primary interests and probable career are in areas of art and literature, philosophy and religion, economics and politics.

Science Education --Study of ways to join the "two cultures;" i.e., to help individuals of the general public to use, understand, appreciate, and support science to whatever level useful and necessary for that individual and society.

Subject Matter Specialists --Scientists in a discipline; science educators across disciplines. (Interdisciplinary specialists are rare.)

Now it is time to follow Tyler's advice and make some lists from the subject matter specialists, scientists, and science educators. The premise is that the main concern here is about the objectives of science for the nonscientist in a general education which applies at any level, K-100. Once that is done the level can be limited and the focus placed on the junior high school years by psychologists, learning theorists, etc.

SCIENTISTS' VIEWS

The easiest way to get a current consensus of the scientists' viewpoints on science objectives in the schools is to refer to the summary volume of the seven-volume NSF study of the results of two decades (1955-1975) of curriculum change. In What are the Needs in Precollege Science, Mathematics, and Social Science Education? Views from the Field (American Association for the Advancement of Science, 1980) three teacher organizations, two science organizations, and four administration and support organizations reacted to the previous findings via a representative panel. Part of one reaction, that of the school boards, has been given in the introduction to this paper. Now the reactions of two prestigious scientific organizations will be considered.

The American Association for the Advancement of Science (AAAS) reacted to the NSF study through its panel by focusing on the social setting, students, teachers, curriculum, laboratories curriculum, laboratories, and teaching resources. The panel made some general considerations about the value and limitation of the study itself, then summed up a great deal that applies to our present concerns about science goals and objectives.

After mentioning that the several NSF science projects are perceived to be elitist in character, the panel quotes an observer saying, "Their greatest impact was on high status, high income, middle class school systems (witness PSSC, Chem Study...)." The panel then continues to point out the "dichotomy between students' expectations and the goals of the curriculum reformers."

The reform efforts tended to emphasize the structure of the discipline, in-depth learning, and laboratory activities requiring considerable thought and insight. To students who are now looking for "relevance," fulfillment of immediate objectives, job-related learnings, and practical applications of science to technology, the new curricula have little appeal. When these rigorous curricula are placed in the prevailing school and community context and when all the handicaps related to facilities, teachers not prepared to use the curricula, disciplinary problems, and the governmental requirements discussed earlier are considered, it is not hard to understand why they are having limited success (p. 61).

Another insightful comment from the panel came after it highlighted problems faced in junior high school science that can be traced to the elementary school, especially inadequate elementary school teacher preparation, effects of the "back to the basics" movement in reading and mathematics (why not in science too?), and demands for accountability and competency. The panel observed:

> One thing that is not clear from a philosophical point of view or from any evidence included in the three reports is why science vocabulary, facts and elementary ideas, and concepts of science cannot be used as a vehicle for the reading process and for correlation with school mathematics. This is a point that deserves serious consideration by school systems and other groups concerned with the quality of precollege science, mathematics, and social science education. (p. 67)

In 1961, the AAAS had committed themselves to curriculum reform in calling together some 50 scientists, educators, and administrators in each of three meetings (Hall, 1961). They begin their report with a quote from George Sarton:

> It is not at all necessary that the average man should be acquainted with the latest theory of the universe or the newest hormone, but it is

very necessary that he should understand as clearly as possible the purpose and methods of science. This is the business of our schools not simply of the colleges but of all the schools from the kindergarten up. (p. 2019).

This quote well reflects the studies and concerns in 1961. It is not enough today. Almost 20 years later, the same organization is now calling for a new national study. It would attempt to reexamine in depth the goals and purposes of American elementary and secondary education, to issue a major new statement for establishing a framework for education, and to provide a rationale and justification for new directions.

> It is the conviction of the panel that education in the sciences should be a major component of all three areas--general, college preparatory, and vocational--and that national attention needs to be directed to the serious problems in science as well as all of education (American Association for the Advancement of Science, p. 75).

AAAS further recommended that this proposed commission be created by presidential appointment, be funded from nongovernmental agencies, and be free from bureaucratic and institutional constraints. It would thus redirect education as the "Committee of Ten" did more than 85 years ago and as statements from Harvard and the NEA did more than 30 years ago. In the meantime, more limited areas should be addressed by specialists. Thus "extensive investigation of the function and role of values in the education of youth is recommended. This is an issue that should also be a concern of the commission" (p. 75).

The panel from the National Academy of Sciences (NAS) spoke of the previous effort, beginning in 1956, as having cost about $1-billion and having been perhaps the best bargain the government had received over the quarter century. But now too many young men and women are leaving high school not only unable to read, write, or do simple arithmetic, but also not able to tell sense from nonsense. They are taken up with the psychic and occult, are unable to make quantitative decisions, and wish rather than think. After further stating that the American people share no common body of knowledge and understanding on which to ground a reliable consensus on such urgent public issues as energy and the arms race, the panel argues for scientific literacy (National Academy of Sciences, 1980):

> The situation argues for literacy in science as an objective of American education fully as urgent as basic skills in the three R's. An educated citizen ought to have not only a general acquaintance with contemporary knowledge about inanimate and living nature but, more important, a disposition and capacity to frame questions and

find answers. One must be able to recognize relevant evidence, make quantitative assessments of rate and scale, and think in rational accordance with objective reality. Some methods of teaching science can contribute to the development of this kind of critical, rational approach to problems; and a reasonably accurate but not detailed understanding of major scientific principles and of the methods and limitations of scientific work--what we here call scientific literacy--can help one to understand and cope with many types of problems. (p. 98)

The panel then emphasizes four main goals for the teaching of science and mathematics:

1. Knowledge is a value in itself. It need serve no immediately useful purpose other than to expand the world view of the individual learner.

2. Knowledge may be useful by helping the individual to live in greater health and happiness, and even to survive better in a competitive society.

3. Important economic and social values are involved. Citizens with knowledge of science and mathematics are necessary for a healthy economy and for future progress; and intelligent action on many public issues depends upon understanding their scientific and technical content.

4. The education may be preparatory to a professional career in science or one of the technical professions. (p. 98)

It considers goals one and four to have been the primary thrust for the previous era. Now is the time to emphasize the second goal--knowledge useful for one's own well-being. For example, biology should now emphasize nutrition, disease and its prevention, and behavior. The third goal, an informed citizenry, was considered to be the one met least successfully.

The panel acknowledged the difficulty of the third goal but also its necessity. "Students can begin to develop critical standards that will help them to sort out and appraise the technological claims and advice they receive through the popular media" (National Academy of Sciences, p. 99).

Finally, recommendations were made regarding how this could be done, mainly through resource and learning centers, teacher institutes, new courses, and learning materials based on the information gained over the last decade. It emphasized (p. 104) that at the junior high school level, 86 percent of the science classes were traditional--general, earth, life, and physical science. The panel thought that courses should be developed at this level in applied physical science, an activity-centered earth science course "appropriate to the abilities and interests of the average ninth grader and a general education chemistry course" (p. 104). The panel argues that greater effort should be spent on developing course materials that have greater appeal to students "not intensely interested in science." Finally, toward the goal of good citizenship, courses must be planned where

> ...delicate steering is necessary to avoid the levels of rigor and scientific sophistication that scare some students away, and at the same time to avoid the mushiness of courses that are about but not of science, or that treat only the social aspects of a topic without giving students a better understanding of the underlying processes and principles. Developing courses to meet the second and third goals is not easy, but we think the effort is very much worth continuing. (p. 104)

It is interesting that the National Academy of Sciences set down as the first goal, knowledge, without breaking it down any further although assuming that this had been attained well <u>if</u> the student had been motivated, able, and disciplined; <u>if</u> there were also a good teacher; and <u>if</u> there were a well-equipped lab! It is interesting also that AAAS called for another study like <u>Science in General Education</u> and specified that values must have a strong emphasis. The National Academy of Sciences stresses scientific literacy for an informed citizenry. But when coursework useful at the junior high school level is mentioned, the courses are not interdisciplinary at all but are in traditional disciplines with a more practical thrust.

SCIENCE EDUCATION VIEWS

Since the subject matter specialists, the scientists, are of most help within their particular disciplines, we now come to a major difficulty. Very few scientists have been able to work effectively in two or more disciplines and, even if many such persons were available, the problems pointed to in the NSF summary might still remain: science as too abstract, too remote, too difficult.

So, those who know individual disciplines next best, but several disciplines perhaps better, are the science educators at university and public school level. While in theory the same goals should exist for the nonscientist in grade 9 and in grade 13, those four or five years can make a very practical difference. Ever since "Piaget went to college" in the early '70s, science educators have been more careful. McKinnon's and Renner's studies (1971) which revealed that fewer than 50 percent of college students were operating at the formal level have put curriculum developers on guard at every grade (p. 1047).

It is not the place here to discuss the methods used in general education courses. This is done quite well by Goodlad (1973) on the basis of a previous curriculum study by Yudkin in 1969. For our purposes Goodlad has listed the curricular goals of three typical American college courses in science for the nonscientist. Note the similarities: stress on scientific facts, scientific method, and place of science in society.

Course A. The broad objectives of the course are:

1. To provide an understanding of those phases of science which affect the individual as a person, and in family and community relationships;

2. To provide an understanding of the place of science in society;

3. To provide an understanding of the scientific attitude and method, insofar as they can serve as tools in dealing with everyday problems of living;

4. To furnish a foundation for the building of an adequate world view.

Course B. The purposes of the course are:

1. To lead to an adequate understanding on the part of the student of the major facts and principles of the physical sciences;

2. To develop the ability of the student to do critical thinking in the physical sciences.

3. To develop certain desirable changes in attitude on the part of the individual student;

4. To develop in the student a sensitiveness to the social values and implications of the sciences.

Course C. The aims of the course are to gain:

1. Familiarity with certain present-day concepts in physical sciences;

2. An appreciation of scientific methods as a way of dealing with problems;

3. An understanding of the impact of scientific developments on society;

4. An appreciation of the readiness of the social order to accept and use scientific findings. (p. 33)

The interesting point made is that Course A is one on human physiology; Course B is a survey course of chemistry, physics, astronomy, and geology; and Course C covers physical and geological topics in an historical setting. Surprising at first, this common emphasis should help us in our general design. But more help will come from investigating science in general education from the junior high school perspective.

JUNIOR HIGH SCHOOL

The British have, over the last two decades, put more effort into developing interdisciplinary science curricula for junior high school levels (ages 13-16) than Americans have. Furthermore, they have given us criteria and examples. Thus, more discussion will be devoted to their efforts. Although the major program in the USA, Intermediate Science Curriculum Study (ISCS), will be considered more fully elsewhere, it will be given a brief treatment here for purposes of comparison.

The developers of ISCS saw the need to take into account: (1) current thinking as to good science education practice, (2) the nature of modern science, and (3) the psychological characteristics of adolescents.

The main goal of ISCS is to develop scientific literacy-understanding science, scientists, and the scientific enterprise: the basic science concepts, and the intellectual processes from which they arose (Hurd, 1970).

In the seventh and eighth grades the emphasis is on physical science principles as being (1) easier to isolate, (2) less complex, and (3) basic to understanding all science. The ninth grade utilizes these concepts in the study of a wide variety of topics, many of which are biological. The emphasis from the beginning is on allowing the student to gradually build on one concept to reach another. In doing this the student is introduced to a series of process skills developed through special exercises. The teacher, being freed from the usual heavy lecture responsibility, is expected to spend more time with the students as they progress through the self-paced exercises.

There have been many parallels between the development of curriculum projects here and in Great Britain, both at the elementary and secondary levels. Besides developing curricula in the individual scientific disciplines, the British also focused on those years when it was certain that all students would be taking science. Thus they emphasized those aspects of science that best contribute to general education. The first such course proposed was one emphasizing observation and that gave an introduction to scientific language, scientific method, experimental method, and apparatus (Lucas and Chisman, 1973). This initial approach is now known as Scottish Integrated Science (for grades 8 and 9). The stated general objectives are:

[Pupils should acquire]...

(A) in knowledge and understanding

1. knowledge of (i.e., ability to recall) some facts and concepts concerning the environment

2. knowledge of the use of appropriate instruments in scientific experiments

3. an adequate scientific vocabulary

4. an ability to communicate using this vocabulary

5. comprehension of some basic concepts in science so that they can be used in familiar situations

6. ability to select relevant knowledge and apply it in new situations

7. ability to analyze data and draw conclusions

8. ability to think and act creatively in science

(B) in attitudes

9. awareness of the interrelationship of the different disciplines of science

10. awareness of the relationship of science to other aspects of the curriculum

11. awareness of the contribution of science to the economic and social life of the community

12. interest and enjoyment in science

13. an objectivity in observation and in assessing observations

(C) in practical skills

14. some simple science-based skills

15. some experimental techniques involving several skills. (p. 21)

The next step was to develop a curriculum that went beyond the previous grade 8 emphasis on student observation to problem-solving skills in grade 9 with applications to realistic everyday situations. Material was to be gathered from each discipline that would identify

> aspects of the particular discipline which can be integrated with similar material from other disciplines to form broadly based courses dealing with various aspects of moral and social education, preparation for leisure and vocation-based activities, and presented by a team of teachers from among the various specialist groups. (p. 33)

From the material gathered, a number of interdisciplinary topics was chosen and outlines prepared, tested, and made available to teachers. Each teacher would choose about five or six topics per year from such titles as microbiology, marine biology, freshwater biology, plant science, nutrition, human sciences, earth science, fuels, dyes, corrosion, surface science, photographic science, optics, astronomy, weather sciences, flow, electric circuits, and electronics.

The objectives that the student should acquire at this level emphasize attitudinal development as well as the skills and knowledge important for social, leisure, and vocational interests. Lucas and Chisman state that:

> Pupils should acquire,
>
> (A) in knowledge and understanding
>
> 1. some facts about scientific aspects of various industries and occupations in the community
>
> 2. some facts about the scientific aspects of various leisure pursuits
>
> 3. some facts and principles in scientific aspects of various topics of social importance to the individual and to the community
>
> 4. information about some aspects of science such as sociology and psychology and about some of the methods by which this information is obtained

5. a knowledge of the function and use of other and more complex scientific instruments and equipment

6. ability to communicate information and ideas about science

7. greater comprehension of some basic concepts in science so that they can be used in familiar situations

8. greater ability to select relevant knowledge and apply it in new situations

9. greater ability to analyze data and draw conclusions

10. greater ability to think and act creatively in science

(B) in attitudes

11. awareness of the relationship of science to other disciplines of knowledge

12. awareness of the importance of science in the working, leisure, and social aspects of the community and society in general

13. an interest and a willingness to participate in science-related leisure pursuits

14. willingness to conform to and an interest in propagating sensible rules for safety and good health for the sake of the community, as well as of the individual

15. an interest in and a willingness to participate in conservation of the natural environment

16. an interest in gathering information about science through all the media of communication

17. an appreciation of man's responsibility to use science for the benefit of society

18. an attitude of objectivity to all decisions and assessments required of the individual

(C) in practical skills

19. further laboratory skills

20. some laboratory techniques relevant to later vocational, domestic, or leisure needs. (p. 35)

Next came Combined Science, an attempt in England similar to the Scottish Integrated Science effort to prepare students who might continue on to specialize in science or have this as their last course. It is less structured, with an emphasis on the unity of approach of the sciences. It introduces students to natural phenomena without resorting to complex scientific models or laws and the strong laboratory component is based on out-of-school experiences or field trips.

However, a third program, Nuffield Secondary Science is quite different and may be closer to our present needs in America. Its audience is the "young school leaver," the 75 percent of average or below average ability (aged 13 to 16) who will not go on in science. The emphasis here is on a course that will be significant for adolescents and be "concerned with realistic matters of adult stature" (Lucas and Chisman, 1973, p. 54). This means that the course must face the personal, economic, social, and moral implications when they arise in connection with science.

The general aims are to equip the students for everyday life in terms of solving problems; predicting the consequences of actions, and evaluating the assertions of politicians, advertisers, or scientists. This would be partially achieved in the science class by encouraging the proper attitudes of mind and habits of thought (Lucas and Chisman). Immediate objectives are

> to provide opportunity for, and encouragement of, accurate observation, deduction of generalizations, inference from concepts or generalizations, design of simple experiments, and formation of hypotheses. In addition the opportunity is taken to improve verbal fluency, literacy and numeracy, and to encourage self-discipline and responsibility for organization of work. (p. 55)

Themes suggested for inclusion in this "real world" and "significant to the student" approach and backed with a full range of background materials, are:

1) Interdependence of living things

2) Continuity of life

3) Biology of man

4) Harnessing energy

5) Extension of sense perception

6) Movement

7) Using materials

8) The Earth and its place in the Universe.

Next came Schools Council Integrated Science Project (SCISP). With the highly flexible Secondary Science completed for the average and lower ability student, SCISP was developed as a general education course for students who are above average in ability in grades 9-11. The goals are mostly intellectual: critical thinking, objective observation, enough knowledge to appreciate science in their lives and to comment on scientific issues in an informed manner (Lucas and Chisman, 1973).

Knowledge

1.A To recall and to understand that information which would enable pupils to take A-level [specialized] courses in biology, physics, chemistry, or physical science, would enable them to follow a job in science and technology, would enable them to read popular scientific reporting and would enable them to pursue science as a hobby.

2.A To understand the importance of patterns to the scientist and to use these patterns in solving problems (both of a laboratory and of a household type.

3.A To be able to recognize scientific problems.

4.A To understand the relationship of science to technical, social and economic development, and to be appreciative of the limitations of science.

Attitudes

1.B To be faithful in reporting scientific work.

2.B To be concerned for the application of scientific knowledge within the community.

3.B To have an interest in science and technology and be willing to pursue this interest.

4.B To be willing to make some decisions on the balance of probability.

5.B To be willing to search for patterns, to test for patterns, and to use the patterns in problem solving.

6.B To be skeptical about suggested patterns.

Skills

1.C To work independently and to work as a part of a group.

2.C To discover and to use available resources such as books, apparatus and materials.

3.C To organize and to formulate ideas in order to communicate to others and as an aid to understanding critical analysis, etc. (p. 81)

Two curriculum models, process approach and concept approach, are joined in SCISP to produce a "Patterns Approach." By using a process approach it searches for patterns among the three fundamental concepts: building blocks, interactions, and energy. How these are related to important ideas in science is shown by the following table. Such relationships are seldom seen in current projects.

Let us now note the trends, commonalities, and discrepancies among the scientists and science educators in the hope of gaining helpful suggestions for future curricular development.

TABLE 1

SCISP RELATIONSHIPS BETWEEN PATTERNS AND IMPORTANT IDEAS

Major Patterns	Important Ideas
The Atom	(a) The atom can be regarded as a series of models (b) The models may be used to explain observable physical and chemical phenomena
Structure of Substances	(a) Solids are assumed to be giant ionic, giant covalent or metallic (b) Liquids and gases are assumed to be covalent molecules (c) Interactions between molecules contribute to overall pattern
Energy	(a) Interconversion and conservation of energy are important principles (b) Man's use of energy is important to the economics and well-being of a community

OBJECTIVES BY BRIDGES AND DIALOGS

One trend that is not often even alluded to now is that change in emphasis from the Big Ideas of Science to the Big Problems of Science [only SCISP remembers the National Science Teachers Association's Theory into Action (1964)]. Instead of the second law of thermodynamics we have energy problems. Instead of atomic models we have pollution problems. It is another sign of general science getting close to the real world. Other trends toward science for leisure and nonscience career goals are especially seen in the British curricula. As the health and education fields depend more on paraprofessionals in medical technology and computer usage, science and technology will be even more relevant.

A trend that might be expected to follow from an emphasis on Schwab's (1962) fluid-static science or Kuhn's (1970) normal-revolutionary science is in historical studies. But as we ask about reading and writing and counting in science, why cannot we have science placed at times in the proper historical setting to show how it developed? Another trend not seen as yet is the linking of humanistic themes to scientific themes. The relationship of music, science, and mathematics in Phythagoras and Kepler is a fascinating study.

With such trends in mind, let me begin a "new" look at objectives with a simple assertion: The role of the science educator is to build bridges and to create dialogues between science and the general public. C. P. Snow (1959) brought our attention to the fact that there is a chasm between the Two Cultures: science on one side and humanism on the other. It was good of him to point out the gap but bad to oversimplify the question. His implicit assumption is wrong.

Science is not monolithic, nor is nonscience (humanism). Just as the disciplines within science differ from one another (biology is not physics and is not biophysics either) so, too, in the humanities. Many economists share their intellectual concerns more closely with mathematicians and physicists than with the political scientists in the next office. Many linguists and modern philosophers also share the interests and tools of natural scientists more often than with their literary colleagues. This is less obvious but true for the layperson as well. With or without graduation from high school and college, each has his or her mode of thought, interests, and hobbies, often connected with science and usually with technology.

And the audience for the scientist and the science educator is just this large and diverse in modern-day America. With such diversity on both sides of the culture gap, it is important to simplify things somewhat. But "Two Cultures" is oversimplified.

We can start by formally dividing the humanistic side into three major groups: literary-artistic, philosophical-religious, economic-political. The scientific side, for now, need be only divided into the physical and life sciences.

SCIENCE	BRIDGES	HUMANISM
		Artistic-literary
Physical		
		Philosophical-religious
Life		
		Economic-political

The second step is to begin building connections from one area to another--bridges of mutual interest. These bridges may be around a person and belief (Darwin in science and religion), around a person and influence (Copernicus and literature), around a mutual tool (statistics in biology and economics), around an aesthetic experience (simplicity in geometry and art), around anything. The bridge may focus on a knowledge, a skill, an attitude, anything. The bridge may be at various levels, joining science and music aesthetically, conceptually. As Tyler asked us to, we make lists. Next comes the hard part. If the science educator is truly a bridge builder, there must now be an analysis of these bridges. The number might approach infinity as we subdivide either side, but let common sense take over here.

The primary role of Science Education is to maintain the bridge, and to encourage the dialogue between scientists and nonscientists by first helping each side clarify its own questions and assertions and then by providing an explanation and interpretation of each side's argument to the other.

The dialogue might well start with a choice between fundamental goals: Know Yourself and Your Place in the Universe or Know Yourself and Your Role in the Universe. (That choice is as significant as that between Copernicus and Ptolemy.)

The most recent demand from the dialogue with society is for a new level of moral responsibility from the scientist, balanced by the demand of the scientist for a new level of scientific literacy (a decision-making ability) from the public. If we see patterns among the bridges this will help us group them and give one group priority over another. Finally must come a balance, second only in difficulty to assigning priorities.

It is useful here to note how the six elements of scientific literacy (Pella, O'Hearn and Gale, 1966) are all found within the confines of this diagram. On the left side would be basic concepts of science, the nature of science, and science and technology. Bridges to philosophy and religion would end with an ethical dialogue, bridges to the right side in general would give a variety of humanistic and social questions. Further, bridges to politics should end in a dialogue that stresses decision-making. This perspective will force us to appreciate the many different nuances of interaction between the many humanistic branches and the many scientific ones. This has not been done very often in the past.

One hopes that it is not out of place here to pose some other possible solutions for the demands by scientists for critical thinking, value judgments, self assurance, scientific literacy, etc. While we could in a most cumbersome way set up criteria for each objective and plot any one student's progress in dimensional space, there is an easier, less scientific way. The levels already established by Bloom in cognition, by Krathwohl in ethical awareness, by Maslow in self-actualization, by Pella et al. in scientific literacy, etc., might be considered by the teacher often during a junior high school course. Perhaps this level of awareness on the teacher's part will be enough to motivate the students toward higher levels.

And there is help for the junior high school science teacher from other quarters, even though not originally written with the early adolescent in mind. It will be the teacher's task to adapt these lists.

A) Courses in science for the nonscience major: Biology teachers have written "courses for citizens" (Hayes, 1980), chemistry teachers have published some 80 chemistry courses for nonscientists over the last decade (Hostettler, 1979), physics teachers focused on 15 recent environmental courses featuring energy topics (Sokoloff, 1978), and college science teachers devoted many articles to history -- a vehicle for science.

B) Professional statements: Scientific editorials have appeared asking for a new profession linking science and engineering with economics and political science for future leadership, praising the 25 scientists who work in Congress for a year to study science in government, and saying that an effective science teacher today is spending 10-20 percent of class time on social issues.

C) Books and Media: Ascent of Man TV series has so far spawned about 500 courses using these films

Television: Connections, Cosmos, Nova, National Geographic, Odyessy, Search for Solutions, 3-2-1-Contact...

Magazines: Science 80, Discover, Sci Quest, Science News, Scientific American

Tools: Teaching with the abacus, slide rule, calculator, computer

Allow me to close in the spirit of Tyler by beginning this last list--recent books for the science interdisciplinarian's shelf. First, The Structure of Scientific Revolutions (Kuhn, 1970), Zen and the Art of Motorcycle Maintenance (Pirsig, 1974), Godel, Escher and Bach (Hofstadter, 1979), then...

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CHAPTER IV

LEARNERS AS A SOURCE OF EDUCATIONAL OBJECTIVES FOR THE MIDDLE SCHOOL

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INTRODUCTION

In proposing a conceptual model for curriculum development, Tyler (1949) proposed that studies of learners be conducted for the purpose of generating curricular objectives. Additional sources include studies of contemporary life outside the school and suggestions from subject specialists. Objectives generated from these three sources are then filtered through philosophical and psychology of learning screens to test their compatibility with the school's philosophy statement of goals, to determine their feasibility of being attained, and to provide guidance in sequencing or selecting appropriate (psychologically sound) teaching strategies for reaching the objectives. Numerous other curriculum models exist, but the Tyler model has received a great deal of support as evidenced by the frequent use of the model in curriculum classes, numerous references in the literature to this model, and extensive use of the model in the practice of curriculum development. The intent of this chapter is to focus attention on one of the sources of objectives, studies of learners, as a source of objectives for middle school science programs.

MEET NEEDS AND INTERESTS AT CURRICULUM OR INSTRUCTION LEVEL

Ideally, a model functions to guide the development of curriculum in a wide range of school environments and situations. Two schools with very different goals might effectively use the same model to develop very different products. A model free of philosophical bias, then, increases the probability of its implementation in a wide range of educational settings. Evidence of extensive utilization of the Tyler model suggests that this model may be relatively free of such bias. However, using learners as sources of objectives may be an exception to the notion of freedom from philosophical bias. It is important to consider this idea prior to discussing ways in which studies of the student facilitate the educational process.

The suggestion that learners serve as sources of objectives generates heated discussion among some educators. Opinions and commitments of teachers and curriculum developers are distributed along a continuum from the extremes of "tell me what you want to do and learn in science class this year" to "how can students possibly understand what is important to know and do in science class?" These polarized views can be traced to at least two major areas:

(1) common misconceptions of the curriculum-instruction relationship, and

(2) differences among individuals and schools based on varying philosophical perspectives related to the purposes of schools.

Both of these areas present frequent problems to curriculum development teams. This is particularly true as they pertain to the utilization of learners as sources of curricular objectives.

Johnson (1968) has developed an interesting model of curriculum which may deal with the problem presented by Tyler's model. Johnson's model makes a clear distinction between curriculum and instruction.

> The curriculum, though it may limit the range of possible experiences, cannot specify them. ...curriculum is a structured series of intended learning outcomes. Curriculum prescribes (or at least anticipates) the results of instruction. It does not prescribe the means...curriculum has reference to what it is intended that students learn, not what it is intended that students do. (p. 44)

Johnson further states that "the source of curriculum--the only possible source--is the total available culture" (p. 45). While this model does not prevent studies of learners being used as sources of curricular objectives, it does suggest that knowledge of learners, in this case, preadolescents, might be used in a different way.

Following Johnson's presentation, one might argue that certain curricular objectives are invariant and should not be changed or eliminated on the basis of knowledge of the needs and/or interests of middle school students. Following this model, one might use the knowledge of students for developing appropriate instructional strategies for attaining an objective. This information helps form the vehicle or mechanism for making the objective relevant to student needs and interests.

An example might serve to illustrate the position described. We are given the curricular objective that students shall correctly add and subtract mixed fractions. The unimaginative teacher might prepare a worksheet containing ten drill problems or dismiss the objective with the full recognition that most middle school students are not "turned on" to operations with fractions. A more creative teacher, recognizing the readiness or lack of readiness of students for the objective, approaches the problem differently. The teacher may select problems related to students' interests which involve the use of operations with fractions. The possibilities, including athletics, hobbies, and dating, are numerous. An even better solution might call for the teacher to have students identify and solve problems involving fractions. The second teacher's approach supports the integrity of the curricular objective and utilizes the interests of students at the instructional level.

It is possible that a common acceptance and utilization of the curriculum-instruction relationship described by Johnson could greatly enhance communication among educators regarding the level of student involvement in the decision-making process. If this model were accepted, there would be minimal involvement of students in developing curriculum and maximum involvement of students (and teachers) in instructional decision-making. While this approach would appeal to a large body of curriculum developers, it would probably cause some concern among those who support an existential philosophy of education. While the model partially circumvents one of the problems identified in the Tyler model, it is still not free of philosophical bias. The philosophical screens established can have a significant influence upon the procedures for developing curriculum.

PHILOSOPHICAL APPROACHES TO CURRICULUM DEVELOPMENT

Earlier, a problem area of differences in philosophical approaches to schooling was identified. While there are probably as many philosophies of education as there are educators, it is useful to examine "schools" or categories of philosophical thought as they relate to education. Sometimes educational programs have an unidentifiable philosophical approach or screen. This may be the result of a lack of planning, with everyone doing his/her own thing. Or it could be that the program reflects an eclectic approach to curriculum development where schools intentionally draw from two or more "schools" of philosophy. Seldom does a school system's philosophy represent a single school of philosophy. One should note, however, that the differences between a school system with an eclectic philosophy and a school system with no planned program are usually very observable.

For the purpose of discussing the role of philosophy in curriculum, Wiles and Bondi (1979) identify five major philosophies of life and education. These philosophies include perennialism, idealism, realism, experimentalism, and existentialism. They reflect a broad range of thought about what schools should be and do (pp. 75-80).

For the *perennialist*, education is constant and is a preparation for life. Students are taught the world's permanencies through structured study and discipline. Being the most traditional of philosophies, it suggests that schools exist primarily to reveal eternal truths which are not subject to change. The students passively receive the teacher's interpretation of eternal truth.

Idealism advocates the reflected wisdom of humanity. Truth and reality are viewed as the consistency of ideas within a person's mind. Schools exist for the purpose of expanding the mind through a study of the wisdom of the ages. Relatively passive students receive, memorize, and report to teachers who serve as models of ideal behavior.

Realism is concerned with the laws of nature and the order of the physical world. Truth is determined through observation and reality consists of a world of things. Students learn the physical laws of nature in contemporary classes like mathematics and science. Teachers impart knowledge and display or demonstrate reality for students to observe and study.

Experimentalism accepts the notion that the world is an ever-changing place. Truth consists of things that presently function and reality is what one experiences. The experimentalist accepts change and looks for ways to expand and improve society. Education utilizes a problem-solving or inquiry format, with teachers assisting students involved in discovering or experiencing the world in which they live.

Existentialism places great emphasis upon the individual and his or her freedom. Truth is subjectively chosen and reality is a world of existing. Education in an existentialist setting would have a loosely defined class and/or course structure. Students are heavily involved in independent study, reflection, and introspection. Teachers are available to interact with students and assist them in their personal learning journeys.

Again, one should note that many school systems, by design, are eclectic in their philosophical approach to education. Also, there frequently are inconsistencies between a school's stated philosophy and its practices. Many contemporary schools espouse the philosophy of experimentalism; however, one might reasonably infer from observation that the school is idealistic or realistic in its philosophy. The development of a philosophical statement for local or national curriculum development efforts should be taken seriously and products and practices should reflect the basic intent of the curriculum. Nationally developed instructional materials should identify their underlying philosophical assumptions to aid curriculum teams in their decisions at the local level.

At this point, the reader may wonder if this chapter deals with educational philosophy or learners as a source of curricular objectives. It is the writer's desire for the reader to see the inseparability of the two and to develop a commitment to developing philosophical screens for curriculum development activities. Earlier, two problem areas were identified which may influence the use of learners as sources of objectives. First, with a clear understanding of the differences between curriculum and instruction, one may elect to meet student needs and interests at the instructional rather than the curricular level. Second, one must examine or develop a philosophical statement of the schools' purpose. While some schools of educational philosophy would draw heavily (if not totally) from the knowledge of learners' needs and interests, others would see little or no need for this type of involvement.

From prior learning and the preceding review of educational philosophies, one can see that student involvement in the learning process varies dramatically. The perennialist and idealist would find little need to apply the needs and interests of students to curriculum building. The realist would be only slightly more interested. The experimentalist and existentialist would be very concerned about input from the school's clients. In fact, the existentialist would argue that the individual's needs and interests should be the primary focus of all learning. Furthermore, the learner should be in command of the learning opportunities and activities. Following certain philosophical leanings, some curriculum developers have little or no further interest in the learner; following other beliefs, a curriculum worker has just begun a long quest for knowledge about students.

PHILOSOPHY OF MIDDLE SCHOOL CURRICULUM

Shifting to a more direct discussion of the middle school curriculum, one sees a somewhat unusual occurrence in educational history. Given that an administrative structuring or restructuring of grade combinations (8-4, 6-2-4, 6-3-3, 4-4-4, etc.) will probably not result in major differences in students' learning, what is the rationale of the middle school? An examination of the middle school rationale (Kindred et al. 1976; Moss, 1969; Overly et al., 1972; and Hansen and Hearn, 1971) clearly reveals a prescribed philosophical perspective.

Statements of middle school rationale are highly associated with experimentalism and to some degree with existentialism. While this writer has little difficulty accepting most of the rationale statements made regarding the formation of middle schools, this is a somewhat unique happening in American education. An across-the-board grade-level organization of three or four years has been proposed. This organizational structure contains an inherent philosophical approach to the educational process. Early proponents of the middle school must have seen this as a method of breaking many schools out of an often stagnant and extremely traditional approach to education. While this has been positively viewed by numerous educators and educational observers, it has presented some problems. Implementation of a philosophy-bound organizational structure in environments hostile to the rationale of the middle school can result in extensive frustration and in products quite different from the intent of middle school advocates.

NEEDS AND INTERESTS OF PREADOLESCENT STUDENTS

Assuming that one accepts the rationale of the middle school, it is imperative to search the literature and conduct studies to obtain information about learners' needs and interests. While there is some information available about the pre-adolescent, generally, there is a paucity of research at this level (Lipsitz, 1977, p. 6; Romano et al., 1973, p. 91). Perhaps a partial explanation for the lack of research in this area is due to a shift of support and interest in recent years to early childhood development. This important area of study has captured the interest of researchers and funding agencies at the expense of other areas of human development. In reviewing research in the area, Lipsitz (1977) states that "not one single researcher contacted during the preparation of this report has expressed satisfaction with the state of research on young adolescence" (p. 9). At this point research provides limited guidance for classroom practice.

The pre-adolescent or transescent years can best be described as a time of variability and change. Students at certain points in the period differ tremendously from their peers. It has been said that differences among seventh graders are greater than the differences between "average" seventh graders and "average" seniors in high school. Pre-adolescence (transescence) is a time of extreme physical, social, emotional, and psychological change. Furthermore, students experience conflicting emotions. They are searching for independence and autonomy yet have a need for acceptance from adults. They are frequently torn between peer and adult demands. They want to accept value systems of adults but need to form their own. They want to be treated as adults but frequently respond in childish ways. They want to fill adult roles but need the security of childhood. Adapting to accelerated physical growth, dealing with internal struggles, and responding to adult and peer pressures places the early adolescent (transescent) in a state of near constant conflict. The pressures of the transescent are natural and necessary parts of his/her development. Conflict and the successful resolution of conflict in a supportive environment appear to help build a healthy integrated personality.

The transescent's acceptance of his/her physical and physiological changes are quite important. In recent decades, the age of puberty has lowered. Typically, girls begin their growth spurt at a mean age of 9.6 years and experience menarche around 12.9 years. Comparable milestones occur two years later for boys. However, these figures cannot be viewed as absolute (Lipsitz, 1977, p. 15). Concern over one's physical appearance and subsequent acceptance of peer group approval is of major importance to the transescent. Thinking that he/she will not reach puberty like other students causes a tremendous amount of anxiety. Students are very conscious about being shorter or less physically endowed than others.

Closely related to physical and physiological development is the learning of new social-sex roles. A part of heterosexual antagonism is the beginning of increased heterosexual interest. A vulnerable self concept is tested through increased interactions with the opposite sex. Also, the transescent is faced with changing sex roles in today's society. Variations in traditional masculine-feminine roles have evolved. These roles are less distinct, with increased flexibility for women in the social structures. While these changes are positively viewed by large segments of today's society, students may experience some conflict from observing family role models which reflect more traditional views. Accepting one's sexuality and developing social-sex roles may not be finalized during the transescent period but may have significant effects on the emerging adolescent and adult (Thornburg, 1973).

Not previously mentioned, but too important to overlook, is the developing intellect of transescents. One of the many significant contributions of Piaget was the notion that children are not simply miniature adults. Children progress through three invariant developmental stages to the fourth and final stage of formal operations. For several years many educational practitioners believed that most adolescents reached the level of formal reasoning between the years of 12 and 15. More recent research indicates that less than half of college freshmen have moved deeply into the formal operational stage (Renner and Lawson, 1977). If this is the case, then middle schools are certainly not working with students who are all making, or have made, the transition from the concrete operational level to formal operati   level. At the same time, it suggests that the majority of stu   ts are concrete operational and need teaching strategies and   ivities which are appropriate for this level of cognitive dev   ment.

Transesc_nts have intellectual and academic interests and needs. Unfortunately, middle school literature frequently fails to recognize or promote these needs. The underlying fear seems to be that the middle school will become a little high school. Meeting the social and psycho-social needs of transescents is necessary but not sufficient to meet their total needs. Johnson (1971) states that "it is an affront to adolescents to assume that they cannot or will not respond to a program with a serious intellectual emphasis.... Dealing with ideas diverts adolescents from their preoccupation with themselves. Even the slow learners can more readily grasp significant ideas than retain masses of inconsequential facts" (p. 72).

A limited number of observations and perceptions of transescents' needs have been identified. There are others, certainly, but this gives a fair representation of some of the needs and interests of this special age group. An important question at this point is, how are these needs translated into educational objectives and practices?

FROM NEEDS AND INTERESTS TO OBJECTIVES

Given the myriad needs of pre-adolescents and a commitment to meet these needs through schooling, objectives and a plan for delivering the program to students are needed. Currently, the middle school movement may be the most viable mechanism for meeting these needs.

Wiles (1976) identifies seven elements which are essential to the middle school program (p. 15):

1) A program concerned with the total development of the learner.

2) A program focused on the individual student.

3) A program featuring individualized learning.

4) A program planned around the needs and interest of the learner.

5) A program humane in nature and emphasizing success and personal growth.

6) A program emphasizing guidance and counseling.

7) A program oriented to the schools community.

Based on the development of the pre-adolescent, Wiles (1976) identifies five areas to serve as the focus for objective and activity development (p. 8):

1) Social Development and Refinements.

2) Promotion of Self-Concept and Self-Acceptance.

3) Promotion of Physical and Mental Health.

4) Academic Adequacy.

5) Aesthetic Stimulation.

As an example of how objectives can be inferred from student needs, Wiles (1976) generates eight objectives (p. 8) from the category of Academic Adequacy (listed above).

Objectives:

1) To develop a base of information sources.

2) To master computational skills and understand the need for them.

3) To develop the ability to communicate ideas and feelings by developing skills in reading, listening, speaking and writing.

4) To develop the ability to identify and apply skills necessary in problem-solving situations.

5) To develop disciplined and logical thought processes.

6) To develop the ability to carefully examine and criticize information.

7) To develop and promote one's intellectual curiosity.

8) To develop an appreciation for processes that will stimulate independent and continued learning.

It is easy to see how these eight objectives can be further defined and developed to provide more precise statements of curricular outcomes. For example, Objective 4, "To develop the ability to identify and apply skills necessary in problem-solving situations," can be further defined to include the development of science process skills. One might develop objectives like the following:

1) The student will serially order seashells using any one of their observable properties.

2) The student will sort a rock collection into groups based on any two observable properties.

While the development of objectives might vary from person to person for a given need, a system such as that used by Wiles allows one to translate a need to objective form. Teachers and students can then develop appropriate teaching and/or learning strategies to attain the objective.

SUMMARY

Educators differ in their views on using the knowledge of learners as sources of educational objectives. Recognizing the differences between curriculum and instruction, some educators choose to make programs relevant to student needs and interests at the instructional level. In this case existing curricular objectives are not changed, but activities and examples are carefully chosen for their relevancy to the learner.

One's educational philosophy has an impact upon one's recognition and acceptance of student needs and interests as sources of educational objectives. The middle school with an inherent set of philosophical assumptions has been developed to meet the specific needs and interests of transescent students. Transescents represent a unique group of learners who are experiencing extreme physical, social, emotional, and psychologica changes. These changes and subsequent adaptations result in special needs and interests for this age learner. These needs can be, and frequently are, translated into objectives appropriate for the transescent learner.

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CHAPTER V

GENERAL OBJECTIVES FOR MIDDLE SCHOOL SCIENCE

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INTRODUCTION

The middle school has initiated new demands on science education in the United States. The middle school concept emerged during the revolution in science education that occurred during the late 1950s and the 1960s. The middle school developed faster, however, than did imaginative science programs which would excite students at those grade levels (about science).

The need of a scientifically literate citizenry cannot be met by teaching science as a "rhetoric of conclusions" or by teaching applications of science from the "tin lizzie days." A change in the objectives of science education came in the United States when man set foot on the moon in July, 1969.

Today science cannot be taught for the sake of science. Its use and applications have become more important. Changing value systems cause people to question scientific and technological contributions. The implications of science on society are discussed in magazines and newspapers and explored by the media. Human and natural resources are important in terms of manpower needs and development of a "conservation ethic." People of the world are in a survival race. The risk benefits of modern science and technology in relation to the quality of life are discussed almost daily in newspapers or television.

In addition, many states are mandating assessment programs for children. Accountability is a theme in most state legislatures. Other mandates such as sex education, environmental education, special education, and teacher certification have had impacts on middle school science.

What follows then, in this chapter, are guides to selection of objectives for middle school science with a variety of sources explored and described. Local curriculum developers and science teachers should find the information useful.

SCIENTIFIC LITERACY

The goal of science education in the next two decades should be to develop scientifically literate persons who understand the interactions among science, technology, and society. This goal is shared by many in the United States, including The National Assessment of Educational Progress (19[illegible]) and the Center for Unified Science (Showalter et al., 1974

Berkheimer (1980) describes a scientifically literate person as follows:

> The scientifically literate person has a substantial knowledge base which includes facts, concepts, conceptual networks, and process skills that enable him or her to learn quickly and to think logically; appreciates the esthetic value of science and technology as well as their utilitarian aspects; understands the limitations of science and technology and the detrimental effects on society if they are not used wisely; and values the quality of life and uses his or her understanding of the interaction among science, technology, and society in his or her everyday problem-solving and decision-making. (p. 1)

Further elaboration of scientific literacy by Berkheimer (1980) attempts to clarify what is meant by the description--"the scientifically literate person" (pp. 9-11).

The scientifically literate person:

1. uses science concepts, process skills, and values in making responsible everyday decisions as he or she reacts with other people and his or her environment.

2. understands the interrelationships among science, technology, and society.

3. understands how society influences science and technology as well as how science and technology influence society.

4. understands that society controls science and technology through the allocation of resources.

5. understands that science and technology can be used to contribute to the quality of life or it may be used to detract from the quality of life.

6. recognizes the limitations as well as the usefulness of science and technology in advancing human welfare.

7. appreciates the esthetic as well as the utilitarian aspects of science and technology.

8. values the quality of life and the quality of the environment and uses these values as well as the understanding of the interaction among science, technology, and society in everyday problem-solving and decision-making.

9. has adequate decision-making and problem-solving skills to make rational decisions and solve problems logically in his everyday life.

10. knows the major concepts, hypotheses, and theories of several different sciences and is able to use them.

11. appreciates science for the intellectual stimulus it provides.

12. understands that the generation of scientific knowledge depends upon the inquiry process and upon conceptual theories.

13. distinguishes between scientific evidence and personal opinion.

14. is aware of some of the moral dilemmas which have developed as a result of advances in scientific and technological knowledge.

15. recognizes the human origin of science and understands that scientific knowledge is tenta tive, subject to change as evidence accumulates.

16. has sufficient knowledge and experience so that he can appreciate the scientific work carried out by others.

17. has a richer and more exciting view of the world as the resu'' of his science education, and

18. continues tc ¸uire and increase his scientific knowledge throughout his life.

Berkheimer, as well as most science educators, advocates that these characteristics are as appropriate for those continuing in some type of scientific career as for those who could be designated as lay citizens in science.

The British View of Science Objectives

Of significant interest is also the view that other countries have about the same goals of science education. The Association for Science Education in England has published the following aims of science education in a brochure titled Alternatives for Science Education (1979).

Science, and science-based or science-related activities, clearly have a contribution to make to the curriculum in general, but the nature of the contribution science is able to make depends on the way scientific knowledge, skills, and attitudes are defined, developed, and deployed. A fundamental issue is the extent to which science studies are seen to serve subject-centered as against more generalized ends. Thus science studies can be defined in terms of the development of the subject--the continuation and extension of scientific ideas--with the following broad aims being the most relevant in terms of school science education:

(a) the acquisition and understanding of scientific knowledge, generalizations, principles, and laws, gained through a systematic study and experience of aspects of the body of knowledge called science;

(b) the acquisition of a range of cognitive and psychomotor skills and processes gained through the repeated involvement in scientific activities and procedures in the laboratory and the field;

(c) the utilization of scientific knowledge and processes in the pursuit of further knowledge and deeper understanding leading to the ability to function autonomously in an area of science studies. This also involves the ability to communicate with others.

In broader curricular terms we can say that the achievement of the above aims enables the individual to

(d) gain a perspective, or "way of looking at the world" that complements and contrasts with other perspectives or methods of organizing knowledge and inquiry, and without which the individual cannot achieve a balanced general education.

In short, the primary justification, and therefore purpose, of science education is to foster and develop, as part of the general education of the individual, a scientific way of thinking, a basic knowledge of scientific ideas, and an ability to communicate with others. The precise realization of this purpose depends essentially on the way science is defined in conceptual and methodological terms.

The above aims can also be regarded as being person centered, in the sense that through the development of an awareness and understanding of scientific ideas the individual contributes to his or her own intellectual development. But science studies, especially when organized around group activities such as practical work and fieldwork that involve interpersonal communication, provide opportunities

(e) whereby youngsters can gain a sense of social meaning and identity as well as personal autonomy.

Therefore a good science education should seek to develop a range of intellectual skills and cognitive patterns which would help youngsters to handle the problems of growing up in, and integrating with, a society that is heavily dependent on scientific and technological knowledge and its utilization.

Finally it can be argued that science studies that include the history, philosophy and social studies of science provide opportunities for

(f) explaining, and therefore understanding, the nature of advanced technological societies, the complex interaction between science and society, and the contribution science makes to our cultural heritage. (pp. 37-39)

The statement also describes how personal and social aims of science education can be further explored by considering the variety of contexts within which scientific knowledge can be deployed. These are classified as follows:

(a) Science as science: The pursuit of scientific knowledge as an end in itself, as an intellectual activity leading to the creation of further scientific knowledge. In this context a science curriculum would seek to establish the essential foundations upon which higher education would build in order to equip the individual to undertake scientific research and development.

(b) Science as a cultural activity: The more generalized pursuit of scientific knowledge including aspects of its history, philosophy, literature and social context to effect a greater understanding of the contribution science makes to society and the world of ideas.

(c) Science and citizenship: The development of an understanding and appreciation of scientific and technological knowledge to enable active participation in the processes of democratic decision making, especially in areas relating to the utilization of scientific developments and their technological applications.

(d) Science in the world of work: The development of an understanding of the way in which scientific and technological ideas are used to maintain an economic surplus and, in particular, the use to which science and technology are put in specific industrial, commercial and social situations.

(e) Science and leisure: The appreciation that science and technology provide a basis for a wide range of leisure activities and pursuits, and the development of a creative knowledge and understanding in this area.

(f) Science and survival: The development of an understanding of the role of science and technology in human survival interpreted in the broadest sense, but including aspects of self-sufficiency, the careful use of resources, and the implications of alternative technologies. (p. 39)

The British propose a science education program that reflects general and specific aims which are on the one hand related to the contribution that science makes to personal intellectual growth and development, and on the other to areas or contexts, within which scientific knowledge is used and deployed. Their (the British) goal is to achieve a balanced science education by giving equal weighting to the above factors.

RATIONALE FOR A REFOCUSING OF MIDDLE SCHOOL SCIENCE OBJECTIVES

The middle school is the strategic location for the development of scientific literacy. The report on The Status of Pre-College Science, Mathematics, and Social Science Education, Volume I: 1955-1975 (Helgeson et al., 1977), indicated that 50 percent of the students in U.S. schools take no science after high school biology. General education in science for all students is essential during the middle school years in order to enable citizens to (1) participate in discussions on science and technology at a popular nontechnical level, (2) comprehend popular scientific articles, (3) realize the utility of science in everyday life, (4) perceive the relationship between science and other spheres of life, and (5) make science-society decisions. Contemporary science cannot be viewed in isolation from the technology which it nourishes and by which it is nourished. Science, as it is today, cannot exist without technology and our survival is dependent upon our knowledge and proper use of this technology (p. 191).

It is no longer adequate to use old methods to teach new ideas. Learning theory as applied to middle school students is promoting new modes of instruction. The studies of Gagne, Bruner, and Ausubel in the cognitive domain are providing excitement for learning studies (see Novak, 1977). The research of Piaget (see Karplus et al.,1977) has brought about changes in what teachers and curriculum developers thought middle school students could do in science. Kohlberg's work (see Hersh, 1979) in moral reasoning and Epstein's (1978) studies on brain development are also forward thrusts in reasoning and developmental theory. Because middle school students have a strong interest in "self," they are concerned about their physiological and social development. The kinds of science activities that will motivate and excite these students are those that will help them understand themselves, their growth and development, their responsibilities, and their enjoyment of the world in which they live.

In short, the traditional image held by middle school students that science is "studying about" plants, animals, rocks, minerals, etc., has to be enlarged into broader contexts. To some teachers, to teach a balance between concept, processes, attitudes, values, and issues will be a real challenge since they may have been fact-centered teachers. Other teachers may have attempted to focus too much on current interests such as sex education, space education, environmental issues, or energy problems at the expense of teaching basic science concepts and principles. A better balance of the goals of science education has to be struck.

Criteria for Selecting Objectives

A "new look" at criteria for selecting science objectives was developed by National Assessment consultants (many prominent scientists, science teachers and science educators from the U.S.) for the 1976-1977 science assessment (National Assessment of Educational Progress, 1979). These criteria, plus examples, provide a model for the new goals of science education which should impact on middle school science programs.

Criteria

The objective should:

1. Entail a basic concept that contributes substantially to the understanding of the nature of the subject area.

   Example: Comprehend the concept that the cell is the basic building block of living organisms.

2. Entail a key concept or idea necessary to understand other bodies of knowledge.

   Example: Understand the concept of half-life, with respect to phenomena such as pollutants, radioactivity, biodegradables, and others.

3. Have a broad application beyond the curricular area.

   Example: Know that water is a factor in food and energy production and thus is of individual and worldwide importance.

4. Be personally relevant and applicable--contribute to the individual's survival, well-being and quality of life.

   Example: Know that each flammable substance has a set kindling temperature and that a flame is not necessary to start a fire. These facts should be considered in the design of buildings, consumer products, and so on.

5. Be useful in potential career preparation.

   Example: Be able to distinguish among a wide range of career possibilities that have a base in science and technology.

6. Contribute to effective social decision-making, especially in regard to issues surrounding persistent societal problems and technological developments.

   Example: Comprehend that survival of the human race requires that we view the earth as a closed system (except for radiation).

7. Contribute to an understanding of self.

   Example: Know that offspring tend to resemble their parents.

8. Contribute to an understanding of the nature, potential and limitations of science.

   Example: Comprehend and be able to apply the scientific assumption that the world is intelligible, causal and not capricious in nature. (pp. 4-5)

While not a NAEP criterion, most curriculum specialists would also add that the objective should be able to be measured.

National Assessment of Educational Progress Objectives

National Assessment objectives were written for both the cognitive and affective domain (1979, pp. 7-10). The major areas in the cognitive domain were (1) content, (2) process, and (3) science and society. These three areas are defined as (1) the body of knowledge in science, (2) the process by which that body of knowledge emerges, and (3) the implications for mankind of that body of knowledge.

The various objectives were organized as follows:

I. Content Objectives

Biological Science	Physical Science	Integrated Topics
Systematics	Matter	Models
Cell theory	Combinations	Equilibrium
Energy transformations	Waves	Change
Heredity	Mechanics	Evolution
Evolution	Electricity and magnetism	Growth
Behavior		Time/space
Growth and development	**Earth Science**	Cycles
Germ theory and disease	Meteorology	Probability
	Geology	Systems
	Oceanography	
	Astronomy	

II. Process of Science

The processes of science were organized into two broad categories: (1) inquiry processes and (2) scientific decision-making.

A. Inquiry processes

Processes of Inquiry

Models	Classification
Assumptions	Observing
Communications	Experimenting
Measurements	Interpretation of data

B. Scientific decision-making. This component is a recent addition to National Assessment objectives. This objective has increased in prominence with the increased concerns about science and technology and the "quality of life." Intelligent, rational decision-making skills are important objectives of science education.

Scientific Decision Making

Problem definition
Criteria development
Identification of constraints
Model generation
Developing solutions

The National Assessment flow chart for decision making is shown in Figure 1 (NAEP, 1979, p. 9).

III. Science and Society. The science and society area is divided into the subareas of: persistent societal problems, science and self, and applied science/technology.

These areas address student knowledge of current problems such as pollution, health and safety, and everyday use of science. Objectives in applied science/technology are directed toward understanding science, and technology, and their implications.

A. Persistent Societal Problems

Health and safety
Environment
Growth
Resource management

B. Science and Self

Everyday use of science
Personal health and nutrition safety
Personal contributions to conservation
Individual responsibility regarding science-related societal problems

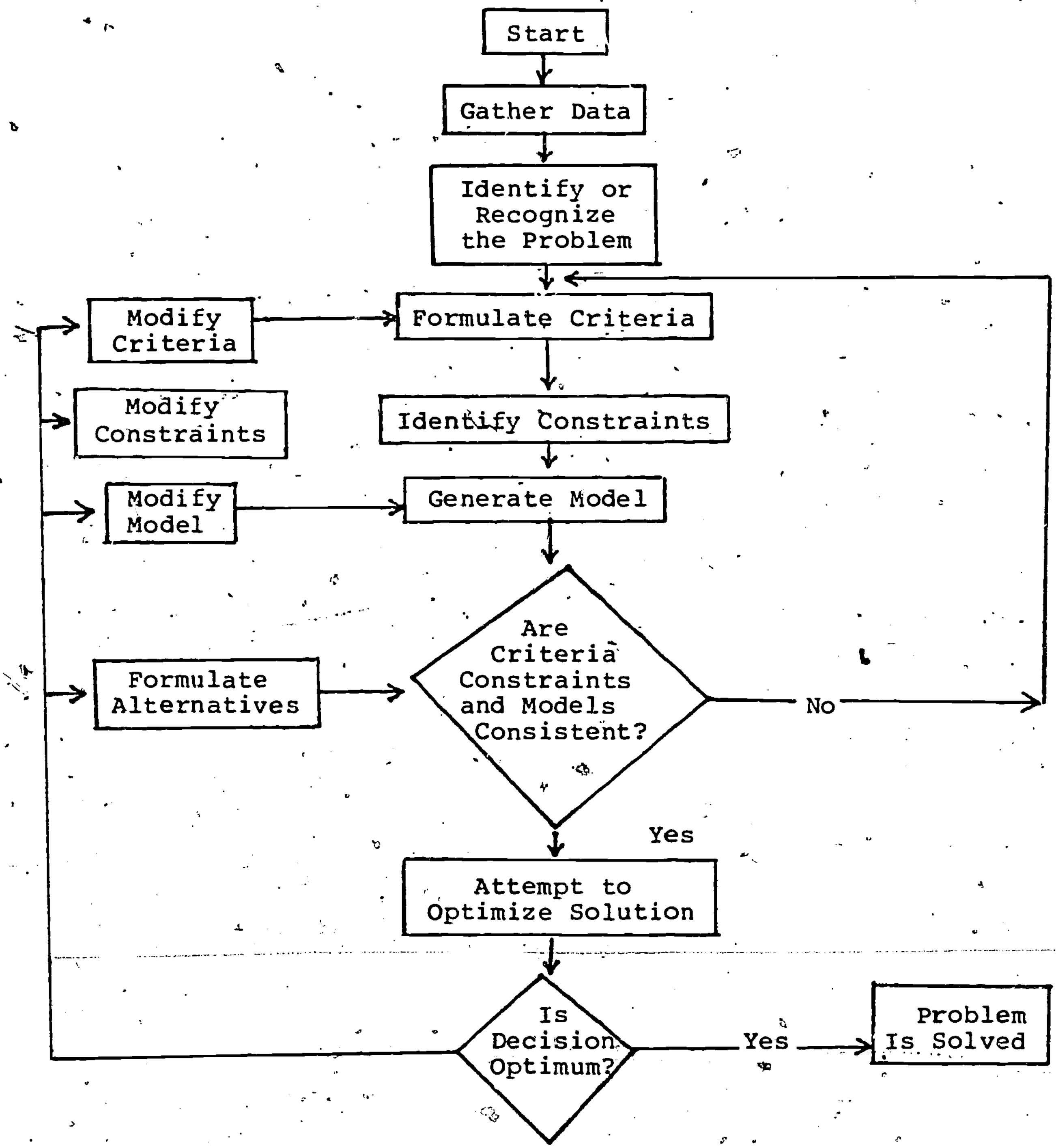

Figure 1. Decision-making Flow Chart

C. Applied Science/Technology

Applications in biological science
Applications in physical science
Applications in earth science
Changes in science/technology

IV. National Assessment Objectives--Affective Domain. The affective objectives of the assessment were designed to be primarily investigative and descriptive--to find out what attitudes and values are held and, ultimately, how they change over the years.

The attitudes sets were:

Attitudes toward science classes. Attitudes assessed in these questions are all related to classroom experiences. Does the student perceive science class(es) to be enjoyable and useful? Does the student believe teachers enjoy science and make it interesting? How do students perceive individualized activities in science class(es)? Checklist items have been included to assess the extent of students' extracurricular science activities, giving us indicators of whether or not they value science as an intellectual activity.

Vocational and education intentions. These questions address students' attitudes and intentions regarding further study of science and the possibility of entering a career in a science-related field. Attitudes about these areas might seriously affect future numbers of workers in science and engineering.

Personal involvement in science. The intent of these questions is to ascertain whether students believe society-related science problems affect them personally or whether students believe they can change societal conditions. For example, some questions were designed to see if students believe that current problems in energy, food production and overpopulation touch their lives. Students are asked if they believe they can make a personal contribution to the solution of a problem such as the energy shortage. Other items deal with whether or not students are willing to help solve problems.

Tools--attributes. These questions assess students' opinions about the utility of the skills, procedures and philosophies of scientific investigation in their daily life. This includes the belief that what is learned in science classes in school is applicable to activities outside of school.

Confidence in science. These questions are concerned with students' belief that science is a beneficial activity. Do students believe science can help solve world problems? Has science improved the quality of life? Questions elicit students' opinions of the degree to which social institutions such as the government should control science and scientific activities.

Support of research. Students are asked to express their attitudes toward the conduct and support of research in basic and applied scientific fields. Attitudes toward such research could influence the direction such research takes in coming years.

Controversial issues. A major theme in these questions is students' opinions and attitudes about important but potentially hazardous or controversial research topics. Students are asked if they believe research should continue in certain areas that entail tradeoffs between potential benefits and perhaps obvious risks. Though no "right" answer exists, it is important to determine students' opinions and shifts in opinion in these critical areas. A scientifically literate population should be able to make choices concerning such research and know the potential risks and gains in new research.

Awareness. These questions determine whether or not students are aware of the assumptions, values and processes of science. Attitudes such as these tend to have a strong cognitive component, because, at the most basic level, they assess whether students are aware that the process of science exists. Awareness questions assess whether students apprehend the tentativeness of scientific theories, the fact that there are multiple solutions to problems, the fact that incomplete theories are useful, the role of self-criticism in science and the empirical base upon which science rests. (pp. 5-7)

Another View of Science Attitudes

To describe scientific attitudes is much easier than to assess them. The State of Michigan Science Objectives (Michigan Department of Education, 1979) list the following attitudes:

ATTITUDES Grades 7-9

Questioning Attitude--Expressing a desire to understand ideas, explanations, and causes of observed events and phenomena.

Disciplined Curiosity--Demonstrating the tendency to engage in systematic inquiry relating to ideas, objects, events, and phenomena in one's environment.

Openmindedness--Being receptive to evidence and ideas.

Withholding Judgment--Seeking and weighing available evidence before drawing conclusions.

Respect for Evidence--Indicating a preference for statements supported by data.

Intellectual Honesty--Being concerned with accurate and unbiased reporting and valid interpretations of data.

Sense of Responsibility--Demonstrating a concern for self, others, and the environment.

Understanding of Self--Being able to identify one's own competencies and limitations. (p. 25)

Objectives Determined by a State Science Teacher Organization

Many state science teacher organizations have been given the task to determine what science competencies students should attain at various levels in the science program. The accountability movement has given impetus to this task and science teacher organizations are responding. Following are the suggested science competencies for students completing grade 8 in Connecticut schools (Connecticut Science Teachers Association, 1980).

CONCEPT OBJECTIVES IN SCIENCE

Concept Objectives in Life Science

Concept 1: Living organisms carry on life functions.

1. Illustrate that living organisms have life cycles; e.g., birth to death, seed to mature plant.
2. Distinguish between living and nonliving things by describing life functions.
3. Discuss health as the absence of disease.
4. Show that disease may be prevented by good habits of eating, resting, exercising, and hygiene.
5. Describe the differences in the structure and function of cells, tissues, and organs.

6. Find patterns in data, events, and life itself.

7. Explain the process of photosynthesis and its dependence upon such factors as light energy, chlorophyll, water, and carbon dioxide.

8. Explain how "like tends to beget like" (genetics), there is a probability in the prediction of future organisms by knowing their ancestors.

Concept 2: Living organisms and their environment are interdependent and are constantly interacting.

1. Illustrate and describe the water cycle.

2. Explain the predator-prey relationship.

3. Give reasons for the need to conserve soil.

4. Compare, contrast, and discuss food chains and food webs.

5. Define symbiosis and give examples of this relationship.

6. Explain the carbon-hydrogen-oxygen cycle.

7. Describe the nitrogen cycle.

8. Explain what soils are and how they are formed.

Concept Objectives in Physical Science

Concept: The physical world consists of the interactions of matter and energy.

1. Give examples of different forms of energy.

2. Identify the three basic parts of an atom, their charges and relative locations.

3. Give examples of chemical changes, e.g. rusting of iron.

4. Differentiate among solids, liquids, and gases, and describe their properties by using the kinetic molecular theory.

5. Relate how an energy change is involved whenever there is a change in the st[illegible] (phase) of matter; e.g., water to steam, etc.

6. Describe how forms of energy may be changed into other forms of energy.

7. Define a calorie and differentiate between small and large calories.

8. Demonstrate an awareness that atomic energy results from the conversion of nuclear mass into energy.

9. Identify sources of nuclear energy and compare fission and fusion.

10. Differentiate among and give examples of the following forces: adhesion, cohesion, capillarity, surface tension, gravity and friction.

11. Explain some of the factors which affect electricity as a flow of electrons.

12. Explain the relationship of temperature to the kinetic molecular theory.

13. Define and illustrate the difference between kinetic and potential energy.

14. Describe patterns in the Periodic Chart of the Elements.

15. Explain that density is the relationship between mass and volume.

16. Define and distinguish between mass and weight, and between mass and volume.

17. Explain how electrical energy can be used to operate devices such as the radio, telephone, computer, etc.

SKILL OBJECTIVES IN SCIENCE

Cognitive**Process**Psychomotor

1. Use measuring devices and record data properly.

2. Make graphs and charts from the data given.

3. Interpret data, charts, and graphs, and make generalizations.

4. Follow directions to utilize simple tests and interpret results.

5. Employ mathematics necessary to convert units within the metric system.

6. Develop an hypothesis from basic data and devise a method to test it.

7. Use, maintain, and care for laboratory equipment.

8. Distinguish between qualitative and quantitative observations.

9. Follow laboratory safety rules at all times.

10. Use "scientific methods" for setting up an experiment which has controls and variables.

11. Communicate information organized in logical sequences orally and graphically using related vocabularies.

12. Recognize that certain teaching devices, such as a 'model' are only aids and are not reality.

13. Apply scientific theories and laws to a given situation.

ATTITUDINAL OBJECTIVES IN SCIENCE

Affective

1. Follow the rules of safety in the science laboratory.

2. Appreciate that science is a way of looking at the universe, at life, and is a part of life.

3. Show respect and appreciation for all living organisms.

4. Appreciate how science is related to one's world.

5. Respect and appreciate the environment based on knowledge.

6. Appreciate the value of critical thinking.

7. Appreciate the value of scientific instruments as extensions of the senses. (p. 25)

MIDDLE SCHOOL STUDENT CHARACTERISTICS AS IMPACTS ON OBJECTIVES

Middle school students are a diverse group of individuals. The Middle School Task Force established by the Michigan Department of Education was made up of a group of middle school principals and teachers and was charged to study middle school students and make recommendations in relation to supervision, curriculum, instruction, and teacher certification at that level

(Michigan Association of Principals, 1976). The group identified the middle school students as transescents-persons going through a variety of developmental changes during which they differ from elementary school youth and high school adolescents. Following is their "composite image" of the transescent.

1. Awareness of body changes; characterized by restlessness and a need to be physically active.

2. Assertion of the need to be independent.

3. Establishment of a strong sense of group identity with peers.

4. Increasing sexual awareness.

5. Increasingly diverse interest expressed.

6. Identification of relationships between and among skills and concepts.

7. Use of skills acquired in earlier years.

8. Apprehensiveness about the impending adolescent years.

9. Development of a distinct self-concept.

10. Dichotomized self; overt behaviors often contradictory and sometimes extreme.

The joint committee of AETS and the National Science Teachers Association (Henderson, 1980), which was commissioned to study the middle school science situation, followed the Michigan description of the middle school student and illustrated how such descriptions could be used to select content objectives which could be used to help the transescent more fully understand himself/herself and the issues of the present time. Table I shows this approach.

TABLE I

RELATIONSHIP OF DESCRIPTORS TO CURRICULUM

Descriptors	Topics
Awareness of Body Changes	Anatomy--especially of muscle, bone, fat deposition, and nervous system Physiology Health--especially as it might pertain to hygienic practices; infections of the skin Hormones--especially as they pertain to growth, sexual development, and secondary sex characteristics
Group Conformity	Animal Behavior--especially as it might apply to roles governed by the endocrine system; populations
Sexual Awareness	Anatomy and Physiology--especially as they might apply to growth and deposition of body fat; endocrine system as it might apply to secondary sex characteristics; behavior
Diverse Interest Expressions	Social Issues in Science--(cloning, genetic engineering, cancer, birth defects, abortion); science fiction; genetics
Applications of Learned Skills	Ecology--especially as it applies to local environment Populations Communities
Distinct Self-Concept	Career exploration Anatomy Physiology Genetics

INTERDISCIPLINARY OBJECTIVES

One of the curriculum study groups established in the late 1950s was the Biological Sciences Study Committee (BSCS). BSCS has continued its curriculum developments with modifications in its basic programs and has explored new avenues. One of these developments is the BSCS Human Sciences Program. It is a program intended for students in grades six through eight. The goals for the program extend beyond those of science education, as can be observed from the objectives (Teaching Human Sciences, 1979). The Human Sciences Program provides means to help students enhance their:

--curiosity about and motivation to study the natural and social worlds around them.

--appreciation of science as a way of gaining knowledge about the natural and social worlds.

--range of interests about and understandings of the natural and social worlds.

--use of science process skills and logical thinking.

--basic skills of reading and following written directions; communicating orally and in writing; and gathering, displaying, and interpreting quantitative data.

--use of decision-making skills.

--knowledge and acceptance of themselves: their body, mind, feelings, aptitudes, interests, and values.

--knowledge and acceptance of and empathy for others: other students, teachers, parents, and those older and younger than themselves.

--self-esteem due to personal success in the program.

--responsibility for their own learning.

--awareness that there are many modes of learning and sources of knowledge serving a variety of human purposes (p. 3).

The BSCS group synthesized these goal statements after intensive study of early adolescents, their needs, concerns, interests, and physiological and cognitive development. The concern for personal development, societal expectations, and changing values thus shows in the selection. The BSCS group came to the conclusion that disciplines are the sources for the curriculum rather than the structure of the curriculum (Schwab, 1974). They concluded that concepts, principles, and modes of inquiry from a variety of life, physical, and behavioral sciences contribute substance and interdisciplinary perspective to the 15 modules of the program.

In the National Science Foundation report, Early Adolescence, Perspectives and Recommendations (Hurd, 1978), one finds the expectation that

> ...The context of the curriculum will likely be societal rather than discipline based. The subject matter will probably be of interdisciplinary nature and selected for its general usefulness in life and living rather than to display the structure of scientific disciplines.
> ...Process skills would be developed as much or more so in the exercise of decision making as in fostering inquiry (p. 58).

Some integrative skills are utilized in the program, such as model building, but the BSCS recognizes that many students have not attained a stage of intellectual development necessary for manipulating highly abstract concepts. Thus, the Human Sciences Program emphasizes concrete activities.

Communication and coding skills are

1. Reading
2. Oral expression
3. Written expression
4. Measuring
5. Mathematical computation

Personal skills are

1. Construction and manipulation
2. Creative thinking
3. Aesthetic appreciation
4. Making value judgments
5. Decision-making

A more complete outline of the Human Science Program (1979, pp. 30-33) follows. In the Human Sciences Program, students will have opportunities to understand and develop position attitudes toward:

1. variation in behavior of organisms.

    identify individual elements of behavior;
    observe and describe a variety of organisms exhibiting a variety of behaviors;
    identify factors that influence and/or direct behavior;
    identify recurring patterns of behavior;
    compare behaviors exhibited by other organisms to human behavior.

2. anatomy, physiology, and health.

identify the basic needs of organisms;
explore structure/function relationships of body organs;
recognize similarities and differences in anatomy and physiology in humans;
identify factors that affect health;
recognize that health is not simply the absence of disease but rather has social, psychological, and physical aspects.

3. diversity and interrelationships of organisms in the environment.

nurture selected organisms;
observe and collect a variety of organisms;
recognize that different organisms require different habitats;
identify variables that affect interrelationships within the environment;
appreciate the uniqueness of individual persons;
infer that all environmental components are interrelated.

4. the ways in which organisms sense, interpret, and respond to their environment.

identify the ways in which organisms obtain information from the environment;
infer the ways in which organisms interpret their environment;
investigate the variability of human perception in a variety of contexts;
investigate the subjectivity of human perception;
recognize the importance of verbal and nonverbal communication in interpreting and responding to the environment;
demonstrate empathy for persons who have problems sensing, interpreting, and responding to the environment.

5. patterns of reproduction and development in a variety of living things.

observe a variety of living things at various stages in their life cycles;
recognize sequences of maturation levels in particular organisms;
recognize the diversity of personal development: physical, social, psychological;
identify some factors that affect maturational levels;

describe similarities and differences in life cycles in different organisms;
recognize similarities and differences in reproductive physiology and behavior in different organisms.

6. the varied roles and functions of different members of communities.

identify the roles of various organisms in a biological community;
recognize the interdependence of organisms in a biological community;
identify varied roles, functions, and relationships of humans in communities;
recognize that in different contexts people have different personal roles;
compare roles and functions of different members of a community;
develop tolerance for others' points of view.

7. the physical environment, its characteristics and interactions.

identify and describe chemical changes in their environment;
explore mechanical and spatial relationships in their environment;
investigate the physical properties of materials in their environment;
explore energy relationships in their environment.

8. the earth, its materials and processes.

identify and describe a variety of earth processes;
identify variables that can affect earth processes;
describe earth-sun relationships and determine how they affect human life;
recognize the interrelationships of earth processes.

9. different ways of knowing.

recognize that there are a number of modes of learning and knowing;
participate in several different ways of learning and knowing;
compare several modes of learning and knowing;
recognize the limitations and usefulness of knowledge;
recognize that interpretation of knowledge is affected by feeling and belief;
infer that knowledge changes, that what is "known" today may be replaced by a better explanation tomorrow.

10. the effect of science and technology on human life.

  investigate past, present, and future development of selected inventions that have demonstrable social significance;
  describe how various technologies have affected the environment;
  appreciate that technology can affect the growth of scientific knowledge;
  recognize the relationship between technology and lifestyle;
  infer that technology can both solve and create problems.

11. the pervasiveness of change (physical, biological, and social).

  identify factors that cause change;
  identify and describe changes in a variety of environments;
  make inferences from evidence of change in the past;
  consider the consequences of changes within a variety of limited environments;
  recognize and appreciate the cyclic nature of selected environmental components;
  predict change when factors affecting change are known.

12. competition, cooperation, and accommodation in communities of organisms.

  observe different social organization in a variety of organisms;
  recognize competitive, cooperative, and accommodative behaviors in a variety of organisms;
  recognize the regular occurrence of conflict among organisms;
  participate in cooperation and conflict resolution in the management of the program in the classroom;
  infer that conflicts can be solved in a variety of ways.

Note that topics 10, 11, and 12 have implicit values ramifications. This is strong support for Hurd's (1978) contention that "it is difficult to conceive of a problem-oriented science course in a societal context where decisions are required that cannot avoid a consideration of values" (p. 58).

INTEGRATION OF SCIENCE AND SOCIAL STUDIES
A PRACTICAL APPLICATION

The Upper St. Clair School District, Upper St. Clair, Pennsylvania (1980), has been experimenting with integration of science and social studies in grades 6 through 8 over a period of several years. The district described the curriculum as the integration of cultural studies and science. Students progress through the program by means of group pacing through separate content, continuous progress through interest content, and individual pacing through integrated content. The separate units are linked when possible by the teaching teams. The integrated units follow:

MAN CURRICULM

INSTRUCTIONAL UNITS

Cultural Studies	Science
LEVEL ONE	
Early Man and Civilizations	Prehistoric Life
Interaction of Cultures	Weather and Climate
The Challenge of Change	Electricity
Economic Man: Producer and Consumer	Modern Life
LEVEL TWO	
Man's Physical World	Geology
Man's Economic World	Technology
Prejudice and Discrimination	Genetics and Evolution
Conflict in Man's World	Ecosystems

LEVEL THREE

Cultural Studies	Science
Mobility and Change	Homeostasis
Dissent and Protest	Chemistry
Government and Politics	Astronomy
Man's Changing Urban Society	Oceanography
LEVEL FOUR	
American Industrial Growth	Diversity of Classification
American Foreign Policy	Physics
The Soviet Union	Meteorology
China: Focus on Revolution	Urban Ecology

CULTURAL STUDIES--SCIENCE INTEGRATION

Basic Themes:

1. Man as a Biological Organism
2. Man in Relation to His Total Environment

Topics for Phase III Integration:

Level One
1. The Interaction of Man and Environment
2. Food and Agriculture
3. Land, Climate, and Vegetation
4. Water, Air, and Weather

Level Two
1. The Earth's Natural Resources
2. Science and Technology: Impact on Man
3. Population: One Earth, Many People
4. Science and Conflict

Level Three
1. Transportation and Communication
2. Science and Man's Health
3. Environmental Problems
4. Urban Planning for the Future

Level Four
1. Natural Resources, Machines, and Change
2. Man and His Global Environment
3. Energy: Challenge to Man
4. /Science and Decision-Making in a Democracy

Course objectives for the Phase III integration are not available, but the topics listed should provide the reader with an understanding of the areas of knowledge that can be integrated.

CONCLUSION

In summary, then, the objectives for middle school science appear to be taking these directions:

1) The general objectives for middle school science should be formulated so as to achieve a high degree of scientific literacy in future citizens of our country. Within this framework, science education leaders and school administrators should promote objectives which meet this broad goal. These objectives should be selected with the intellectual development, the societal needs, and the interests of early adolescents in mind.

2) The objectives should guide teachers to select "hands-on" science experiences which would allow early adolescents to learn the processes, skills, and knowledge needed for the development of concrete thinking. There must be provisions, however, for those activities which aid remedial skill development as well as more abstract experiences that enhance development from concrete to transitional to formal reasoning ability.

3) State science teaching organizations, the National Assessment of Educational Progress, and curriculum development centers are pointing out that scientific literacy has many dimensions. These groups have produced publications which indicate that science objectives should be extended to include science concepts, processes of science, science/society issues, science skills, attitudes toward science and scientists, environmental problems, and applications of science and technology. All students, regardless of color, physical handicaps, or social status, need to be exposed to a science education including the aforementioned elements. To include all of the objectives in a middle school science program will require major changes in curriculum guides and classroom teaching strategies. There is very strong evidence to support this new view of science in the middle school.

4) Personal-social objectives are also important in middle school science. When students can accomplish activities that are geared to their stage of intellectual development they gain confidence in themselves and are motivated to try more difficult tasks. When they study science/societal issues or concerns about technological advances they understand better how they fit into a scientific and technological world. These activities assist in making science relevant to them and they can see why the study of science is worthwhile. Many students may be motivated to study science in high school and select some field of science or technology as a career. The selection of objectives which enhance the personal-social development of middle school students is clearly in order.

5) Schools at the frontier of change at the middle school level are experimenting with programs that integrate science with the behavioral sciences. A major curriculum project, the <u>BSCS Human Sciences Program</u>, demonstrates how this integration is done. The fused science-behavioral sciences objectives offer creative dimensions to the rethinking of objectives for middle school science.

The middle school science program, whether separate or integrated, has a pivotal place in the life of a developing early adolescent. A broadly based, exploratory, guided program will enrich the life of the early adolescent. This view seems to fit the assertion of Great Britain's Lord Bullock (The Association for Science Education, 1979).

> All I am sure of is that the more it is possible, legitimately, to move away from a monolithic, mechanistic, dehumanized image of science; to establish a view of it as a humane study, deeply concerned both with man and society; providing scope for imagination and compassion as well as observation and analysis; and calling, in those who succeed in it, for outstanding personal qualities, the easier it will be to overcome the sense of alienation which turns many young people away from it. (p. 38)

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CHAPTER VI

THE FORMATION OF SPECIFIC OBJECTIVES AND LEARNING ACTIVITIES

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INTRODUCTION

Reasonable educational goals that are delineated into usable instructional objectives are the foundation of sound effective curriculum and instruction. The formation of specific objectives is influenced by several external factors and is screened by educational philosophy, psychology, and experiences (Tyler, 1950). External influences that justly deserve consideration when developing science curricula are the nature of science, the needs of society and the student, and the nature of the learner.

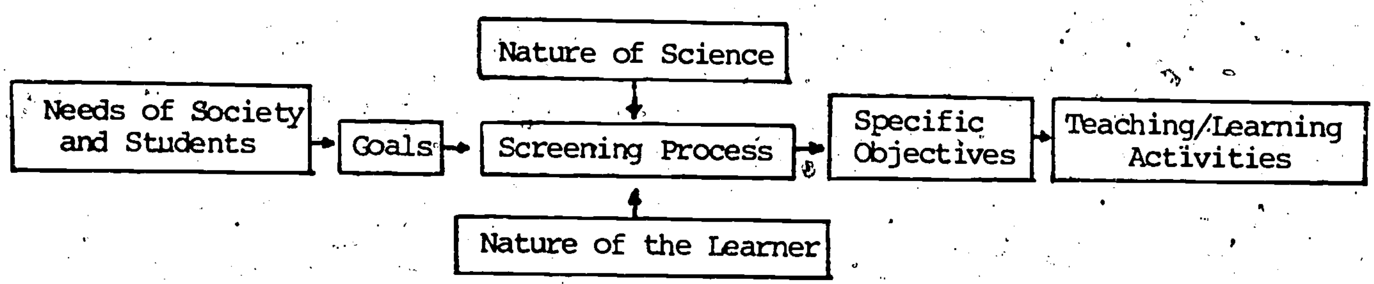

Figure 1. External Influences in Tyler's Model

Each of these independent factors interacts to influence not only what we teach but how we teach science. Societal, student, and content considerations stimulate the initial broad general goals; furthermore, the nature of the learner, the nature of science, and other cultural factors are woven into the philosophical and psychological screening of the goals. Teachers acting as curriculum developers must have a feeling for each of these factors to more effectively formulate specific objectives, select or develop activities, outline teaching/learning procedures, and devise evaluation techniques.

VALUE OF SPECIFIC INSTRUCTIONAL OBJECTIVES

Instructional objectives are attempts to define the learning end points of instruction. Three decades of discussion, exploration, and argumentation have followed Tyler's (1950) plea that educational objectives be specific statements of student change. Behavioral objectives initially enjoyed "more popularity than understanding" (Montague and Butts, 1968, p. 33). Presently the popularity has faded and the general understanding has only slightly increased. A variety of educators have stressed the value of highly specific behavioral objectives in teaching (Mager, 1968; Kurtz, 1965; Krathwohl et al., Bloom and Masia, 1964; Bloom, 1956). Montague and Butts, 1968, p. 35, summarized a critical issue regarding behavioral objectives: "Can the general objectives be stated in behavioral terms so that we can measure student progress through observation of specified behaviors?" Montague and Butts were focusing on problems related to the affective domain, but the danger of describing trivial behaviors as a result of increased specificity crosses all domains. Weber (1974) suggested that certain areas, such as inquiry, contradict the high degree of prespecified behaviors. Boyd (1972) pointed out that inquiry consists of a set of operations carried out in a variety of orders. Prescriptive terminal objectives might well add a degree of rigidity which would turn creative exploration into the mechanistic, step-by-step scientific method of past decades.

Birnie (1978) provided additional insights regarding science educators' avoidance of identifying affective objectives. He believed that (1) value teaching is seen as brainwashing, (2) little effective teaching materials are available, (3) ineffectual assessment techniques are available, (4) science is viewed as an inappropriate subject vehicle for conveying values, and, finally, (5) the link between behavior and affect is tenuous at best. The avoidance of including affective objectives in science may imprint an incomplete definition of science, "after all, [science] is a dynamic enterprise constructed by people who have emotions, morals, and biases, people who develop attitudes and values, and people who make decisions, based not only on what they know, but what they feel" (Birnie, 1978, p. 29). Herron (1977) cited cases where values are part of the implicit curriculum. The importance of these implicit objectives may be more valuable than the specified objectives. Surely curiosity, questioning, analyzing, verifying, logical probing, and soundness of data are educational objectives that science is well-equipped to teach and that may be of value in other facets of life.

Research results related to benefits of specific instructional objectives are not conclusive, but a potential pattern is starting to surface. Johnson and Sherman (1975) provided high- and low-ability experimental students with a list of behavioral objectives (for Intermediate Science Curriculum Study), while control students were not provided such focus. Significant ($p < 0.05$) differences were found in favor of the experimental group and between low-ability groups. The authors suggested that the results may indicate that high-ability students do not need such external structure to focus their learning, while such organization helps the less able students. Martin and Bell (1977) used a similar approach with vocational students in a metric measurement unit and found significant ($p < 0.05$) differences favoring the experimental and high-ability groups on achievement, critical measurement operations, and retained attitudes. Martin and Bell's results appear to be compatible with Johnson and Sherman's results since their high-ability group was selected from a special population normally considered slow learners.

Olsen (1973) provided an experimental group of ninth-grade physical science students with behavioral objectives in advance of their studies, while the control group received instruction without such advance knowledge. Results indicated that the experimental group performed significantly ($p < 0.01$) better than did the control group on both posttest and retention test achievement.

Bryant and Andersen (1972) explored the influence of advance knowledge of behavioral objectives on the achievement of eighth-grade black students. Results indicated no significant ($p < 0.05$) effect to support advance knowledge of behavioral objectives. A significant ($p < 0.05$) result was found supporting training teachers to develop performance objectives. Bryant and Anderson's study pointed out the potential value of instructional objectives in terms of the teacher planning process. Baker (1969) stated that "teachers' faulty understanding of objectives, indicated by their inability to provide relevant classroom practice and to identify...test items, given objectives, may account for differences in the appropriate selection of activities and test items" (p. 5).

If specific instructional objectives do nothing more than clarify teachers' thinking and planning, they are worthwhile. Likely it makes no difference whether the objectives are written out, as long as the teacher <u>thinks</u> specific instructional objectives. Little evidence <u>has been</u> collected regarding specific instructional objectives' greatest value--as a compass to direct the instructional process. Davis <u>et al</u>., (1974) pointed out that learning objectives are an essential component in all learning systems, specifically:

> In planning for teaching, they provide a guide for choosing subject matter content, for sequencing topics, and for allocating teaching time. Learning objectives also guide the selection of materials and procedures to be employed in the actual teaching process. (p. 28)

Furthermore, learning objectives provide a firm platform from which to assess student achievement, teaching effectiveness and future revisions in the instructional system. Engman (1968) provided a four-phase system which utilizes objectives as a foundation for instructional planning (Figure 2).

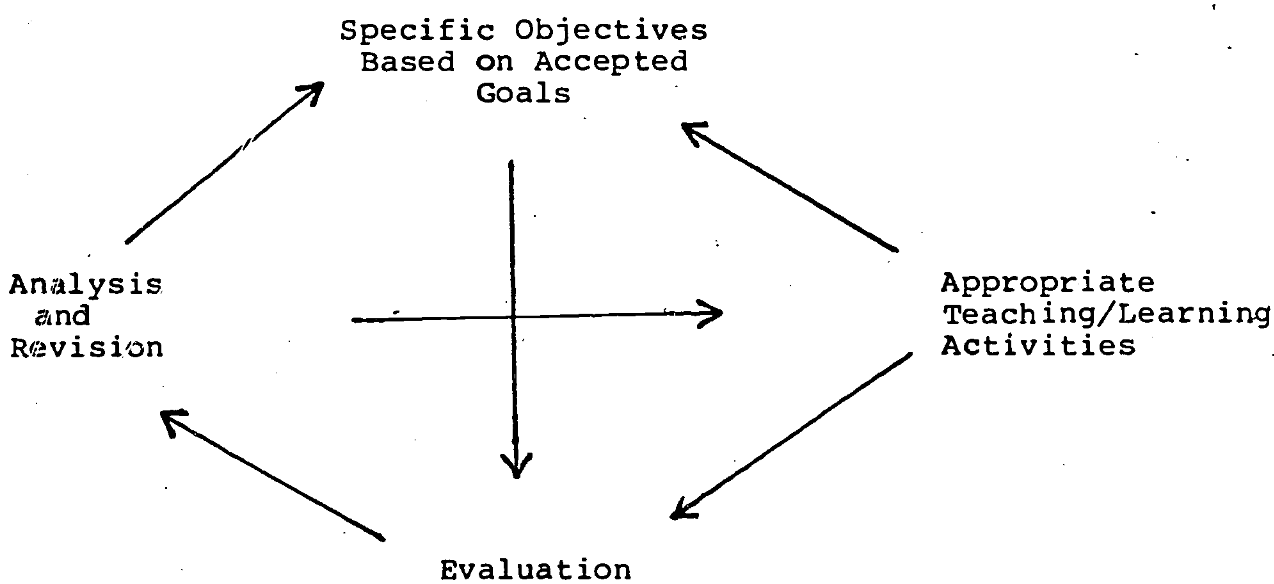

Figure 2. Objectives-Based Planning

Engman's model places stress on clear, comprehensible instructional objectives. The instructional objectives need not follow to the letter Mager's (1968) behavioral objectives format, but every effort needs to be applied to formulate clear, concise, nontrivial outcomes for learning which convey the intended meaning to fellow educators, students, and parents. Instructional objectives that accomplish this goal generally contain an indication that the learner is expected to perform, express, or exhibit a task under certain conditions at a specified level. The statement of the desired performance, expression, or exhibition facilitates Phase II--the selection or development of appropriate learning activities. The performance conditions and level, coupled with the task description, direct the teaching and learning evaluation phases of the teaching/learning enterprise. A statement of the acceptable level of performance need not mandate a mastery teaching/learning strategy, for multiple levels of performance could be defined for specific points on the traditional grading scale. Engman (1968) pointed out that failure to attain the stated objectives could support several inferences; i.e., (1) unrealistic objectives, (2) inappropriate teaching/learning experience, (3) poor evaluation procedures, or (4) unattainable level of learning to be achieved. Unrealistic objectives may be a result of inadequate consideration and screening of the educational goals in terms of external factors. Inappropriate teaching/learning activities may result from hasty or ill-advised selection and development of the associated teaching/learning activities which are incompatible with the learner and stated instructional objectives. Formulation and screening of realistic instructional objectives and appropriate teaching/learning activities will be addressed in the remainder of this chapter.

FORMULATING SPECIFIC OBJECTIVES: DELINEATION AND SCREENING

The formulation of specific instructional objectives involves two processes: delineation and screening. The delineation procedure develops clear, concise statements of student achievement. Mager (1968) stressed the need to identify "who, what, under what conditions, and at what level" as basic conditions for specific instructional objectives. Historically the greatest ambiguity occurred regarding describing the student action in terms of concise verbs which consistently conveyed the same meaning. Several curricular programs have tried to identify a set of appropriate action words for instructional objectives, but Science: A Process Approach (AAAS, 1973) has identified and used nine action words to develop a total program. Each action word is clearly defined and no multiple meanings were used. Much criticism was directed toward Science: A Process Approach because its focus was science process, leaving other goal areas unconsidered.

The screening process is somewhat less mechanistic and less well discussed in the literature. Tyler (1950) mentioned screening but did not clearly describe the process. It appears as though the screening process is an internal validation of the proposed objectives that occurs simultaneously with the writing process. The teacher is constantly delineating goal statements in terms of his/her professional education and experience. The same set of external influences that initiated the educational goals are part of the fundamental fabric in the screening process. The nature of science, the needs of society, and the nature of the learner, as understood by the teacher, are critical factors in the screening process.

The Nature of Science

The nature of science is an influence to which many teacher education programs pay only minimum lip service. Science teachers must devote time and energy considering why science is unique; how it differs from the arts, humanities, and philosophy; and why it should be learned by students. Robinson (1965) provided an interesting description of science that illustrates the integration of science skills, process, knowledge, and logical reasoning. Figure 3 illustrates the symmetrical structures of science; cyclic as it is self-verifying, process and product, and inductive and deductive.

Feynman (1965) suggested that science "was the belief in the ignorance of experts." Such a questioning, searching approach illustrates the inquiry thread in the fabric of science. Newton (1970) suggested that inquiry is "messing around with some concrete object or event, checking to see if one's ideas about it are consistent with what is observable and verifiable" (p. 6). Stone et al., (1971) stated that "the act of asking questions, getting information, and asking more questions that eventually lead to both an understanding of a phenomenon and a basis for the formulation of more sharply focused questions are characteristic of the inquiry" (p.45).

Schwab (1964) pointed out that inquiry can (1) result in the production of new knowledge and (2) allow experimental techniques to be created and perfected. Schwab identified two types of inquiry: stable and fluid. Stable inquiry is designed to acquire new knowledge to fill an existing gap in the subject area and the inquirer's cognitive structure. In stable inquiry the inquirer accepts existing knowledge and allows it to guide his investigation. Stable inquiry usually leads to extension of the basic assumptions into new and unique situations. If contradictory data are found during stable inquiry, the inquirer must question his original assumptions and guiding concepts, turning stable inquiry into fluid inquiry. Fluid inquiry capitalizes on inductive reasoning to produce generalizations to describe observed events. Schwab suggested that fluid inquiry's purpose is to develop new theoretical structure and principle on which later stable inquiry can add new scientific knowledge. It is this fluid nature that allows the sciences to constantly question the validity of existing knowledge. There is no set method for fluid inquiry and failures are common results. No value judgment need be imposed on failure, for like science truth, failure is temporary and only serves to direct the next inquiry.

Robinson's model provides a firm foundation on which more realistic science objectives, activities, and teaching strategies may be based. The decision to teach product and process utilizing specific logical strategies can be clearly justified

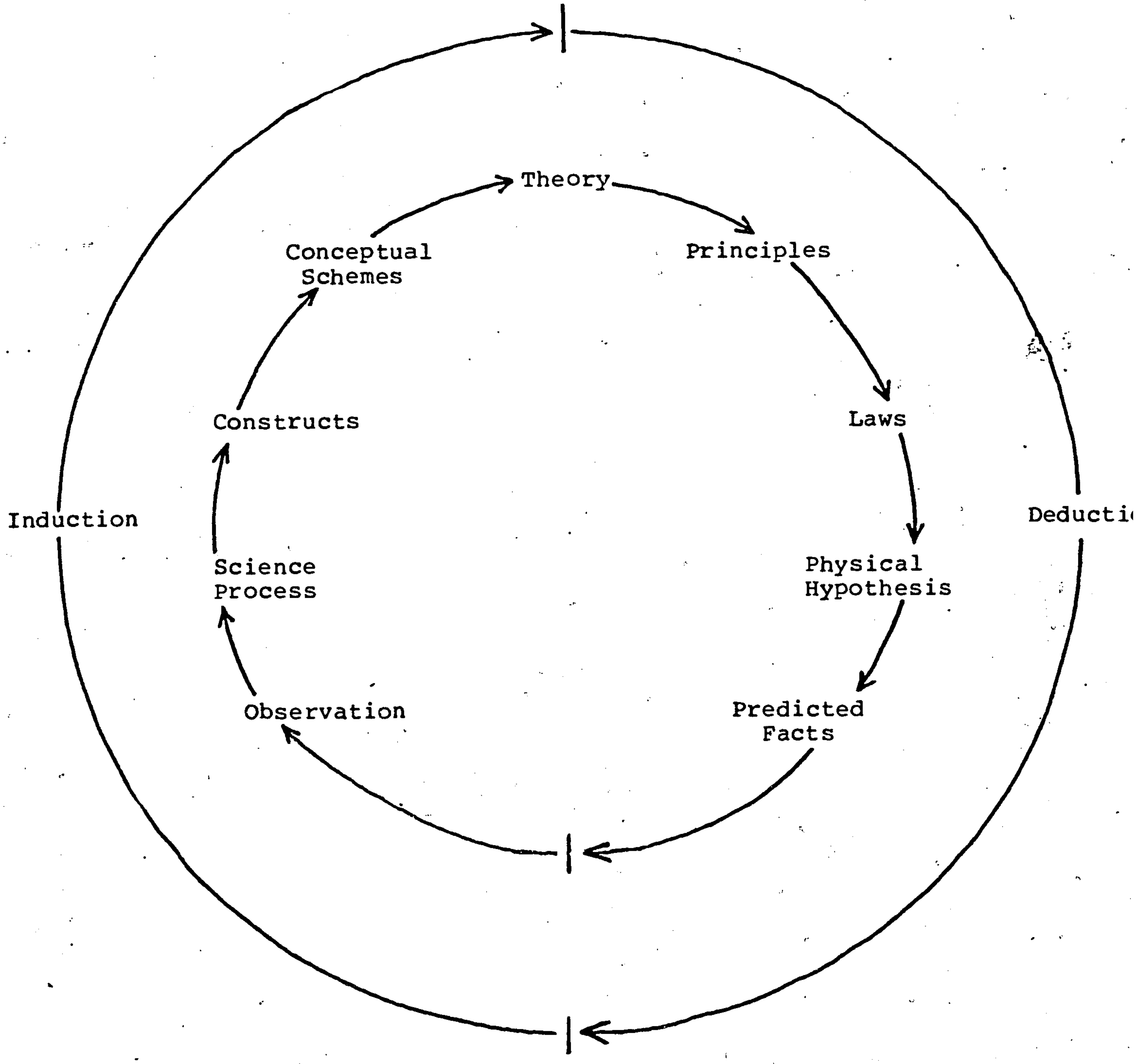

Figure 3: Nature of Science

by the nature of science. The arguments of process or product and inductive or deductive cannot be settled using the nature of science exclusively; other external factors need be considered simultaneously.

Boyd's (1972) diagram of inquiry can be used to illustrate both stable and fluid inquiry (Figure 4). Note that between the "problem" and "revise hypothesis" there may be numerous inquiry pathways, not just the rigid steps of the scientific method. Therefore science teachers should not preach the proper inquiry steps but only help inquirers to develop an effective, flexible strategy by sorting out the more productive moves from the less productive moves.

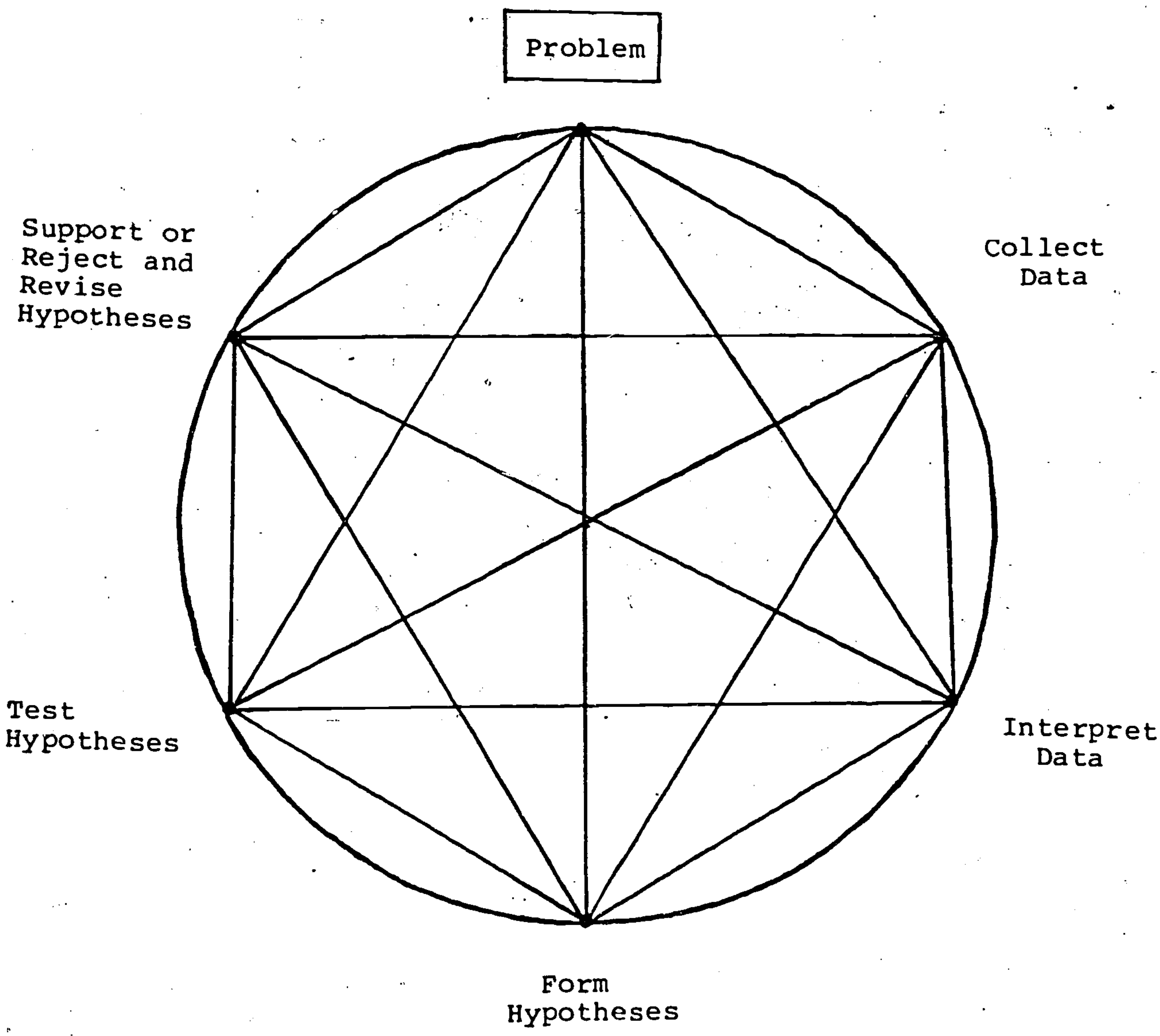

Figure 4. Inquiry (adapted from Boyd, 1972).

Thus, science can be considered to be a human endeavor that attempts to search out, describe, and explain patterns of events in the universe. The scientific searching can be both inductive and deductive and is not a fixed stepwise procedure. Science may produce descriptions and explanations that are short-lived, as the cyclic nature of science constantly questions existing information as well as searches for new understandings.

The Needs of Society

The needs of society and the students specific to science are constantly changing and differ from one location to another. Historically, the goals for the middle grades were to prepare students to leave school and join the work force at home, on the farm, or in industries. Later, the goals became to pursue further studies in high school and university. The late 1970s and the 1980s appear to be painting a new picture. The massive number of students who once accepted high school and university education as a normal way of life that leads to a richer future are now questioning the whole concept of higher education. The lack of vocational and professional opportunities at the end of the university tunnel has set a high percentage of the society and student population at odds with the lofty 1960 science goals of the middle grades. Presently parents, students, and society want the students to exit middle school science courses

a) knowing how to think, learn, and work;

b) having an understanding of the world of work and possible career opportunities; and

c) possessing basic fundamental skills, processes, attitudes, and knowledge.

Many facets of society believe that present-day students are not encouraged to think for themselves, thus developing good old common sense. Likewise, many employers believe that students should be able to teach themselves how to do simple tasks. Criticism regarding work opportunities for students suggested that the training time necessary to get them to do the simplest task was too much, making the whole program inefficient and financially not feasible. Parallel to these two goals is the societal belief that thinking and learning takes hard work and that all learning cannot be fun. Society believes that students need to develop the stick-to-itiveness which, coupled with learning and thinking skills, will help them solve difficult problems they face in the future.

Many parents want their children to be aware of the career opportunities of the future, since a disproportionate number of professional and work opportunities open to today's middle school students in the 1990s presently do not exist as careers. Parents are not generally asking for specific vocational education, but rather for an opening of, or retaining open, career opportunities for their offspring. Historically, students in the middle grades in 1970 were unaware of a myriad of careers available to them.

The third major demand area of students and society consists of the traditional science domains of cognitive knowledge, cognitive science processes, affective, and psychomotor skills. What is basic, essential to future learning and living, has been discussed by science educators since the beginning of formal schools. It is unlikely that present demands regarding these areas are any more clearly defined than before.

The Nature of the Learner

The nature of the learner in the middle school is likely the most difficult external factor to consider in Tyler's model. Several theorists appear to have potential in guiding the expectations and insights of science educators. The constant ebb and flow of popular learning theories can be seen in the research literature and somewhat later in school practices. A high percentage of middle school teachers have adopted an eclectic learning psychology, melding together suggestions, practices, and principles of Skinner, Gagne, Ausubel, Piaget, and others. Each of these theories provides useful insights regarding transescent learners, but cognitive development appears to be uniquely suited to Tyler's model since it supports the a priori considerations of the nature of the learner. Renner and Phillips (1980) stated:

> Traditionally, a person's intellectual development was considered to be a function of all his/her educational experiences; in other words, learning determined intellectual development. The Piagetian model states the converse--intellectual development determines what can be learned. (p. 194).

The Piagetian model of cognitive development stresses that learning outcomes and activities must be selected with care such that they are appropriate to the target learners. Doyle and Lunetta (1978) stated that "teachers must offer one activity with which each child can interact at his own level or have a large number of interesting activities of varying difficulty" (p. 478).

Recent findings regarding students' cognitive development and the cognitive requirements of various instructional procedures in high school have potential guidance in middle schools. Middle school-aged children represent a span of cognitive stages which generally includes concrete operational, formal operational, and the transition between these stages. Few data focus specifically on middle school students regarding their cognitive development. Phillips and Shymansky (1978) collected data on junior high school students indicating that a sizeable number of students performed lower than would have been expected on the multiplicative classification, three-dimensional measurement, and controlling variables tasks. Further studies of university-aged students suggested that a significant number of students do not fully exhibit formal operations and may never develop the abstract reasoning skills associated with formal operations (Yore and Phillips, 1979; Good and Morine, 1978; Lawson et al., 1978). Recent data on several fifth-grade classes for weight, solid, liquid, number, distance and area, conservation tasks, and a multiplicative classification task revealed that up to 35 percent of the students did not provide sufficient reasons for a majority of conservation tasks and 75 percent could not correctly name elements using multiple attributes in an extended classification matrix. Wood (1974) outlined the science process capabilities of learners in concrete, transitional, formal operational stages (Table 1). Woods' matrix keynotes several potentially ripe process areas for middle school science instruction. Early years of middle school might focus on quantitative observation, multiplicative classification, controlling single variables, and inductive generalization, while later years might emphasize controlling multiple variables and deductions. Lawson et al., (1978) suggested that a three-phase-hypothetico-deductive logic (Figure 5) reflects the formal thought described by Piaget. A summary of available cognitive development results appears to suggest that middle school students are generally in the concrete operations stage of cognitive development with smaller percentages in pre- and post-concrete operational stages.

TABLE 1

PIAGET-PROCESS MATRIX

Science Processes		Middle School Students' Stages of Cognitive Development: Concrete Operational	Formal Operational
Observation	qualitative	X	X
	quantitative	X	X
Classification	single attribute	X	X
	multiple attribute	X	X
Controlling Variables	single variation	X	X
	multiple variation		X
Generalization	induction	X	X
Testing Hypotheses	deduction		X

(Adapted from Wood, 1974)

It is likely such a deductive process that allows the formulation of prediction based on plausible hypotheses differentiates the formal operational learners from the concrete operational learners. The middle school science class provides a fertile context from which to intellectually tease, promote, and prompt the development of the hypothetico-deductive logic. Lawson et al., (1978) found approximately 15 percent of the sixth- and eighth-grade students sampled possessed the probabilistic and correlational operations associated with the formal operational stage.

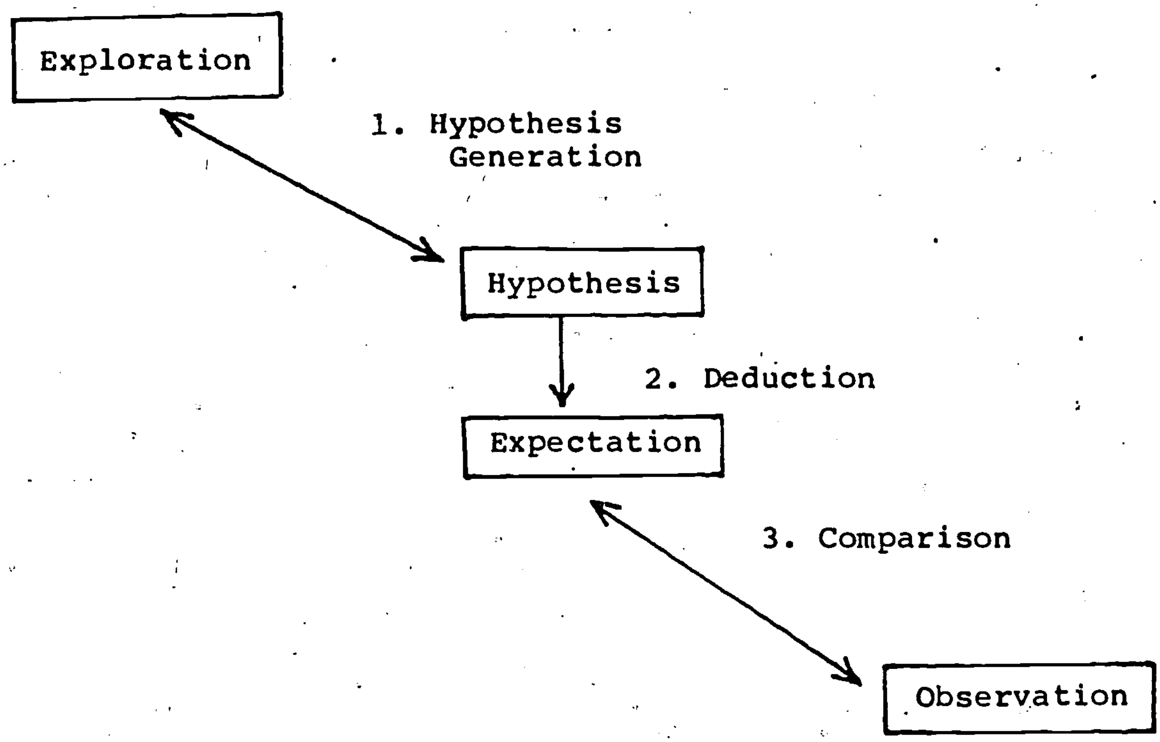

Figure 5. Hypothetico-Deductive Thought (Lawson *et al.*, 1978).

Several science educators have considered the logical thought requirements of biology, chemistry, and physics (Lawson and Renner, 1975; Herron, 1975; and Renner and Grant, 1978). A summary of the results generally indicates that physical science concepts are taught at a level of logical thought requiring formal operations, while biological science concepts are taught at a concrete operations level. Herron (1975) and Renner and Grant (1978) indicated that a high percentage of students in physical science classes do not demonstrate the formal logical operation required by the content being investigated. Ball and Sayre (1974) found that junior and senior high school students' science achievement directly reflected their cognitive development.

Generally, the cognitive development research in science education suggests that teachers should realistically consider the logical thinking ability of the learners when defining learning outcomes and selecting learning activities. Herron (1975) suggested that science teachers minimize the degree of abstractness of a science concept by using instructional techniques and aids which maximize the level of concreteness. Physical models, computer-simulated diagrams, and films may have potential value to minimize the abstractness. Developing instructional strategies that allow students to interact with concrete materials and to interact socially with peers having different cognitive development under different inquiry situations may encourage cognitive growth (Johnson and Howe, 1978). Such a peer teaching situation appears to provide the proper balance of cognitive accommodation and disequilibrium to encourage the development of new, more sophisticated, logical operations and schemata. Lawson and Renner (1975) outlined a teacher's pre-instructional responsibilities regarding the formation of objectives and learning activities as

1) isolating critical essential science goals which "provided the learner with his own understanding of the discipline's structure (p. 342);"

2) identifying inquiry-oriented laboratory investigations which facilitate the students' structuring and understanding of the specific science objectives associated with critical essential science goals; and

3) assuring that the investigations are developed for active inquiry and that requisite concrete materials are available.

One must realize that inquiry involves an active search which might involve physical and/or mental manipulation of materials, ideas, and symbols.

The general goals for the middle grade science programs encourage a balanced process, content, skills, effect, and thinking approach. Each of these broad goals can be defined more clearly as it is screened by the individual teacher's philosophy, psychology, and experience which are tempered by, and mirror in part, the external factors listed earlier; i.e., nature of science, needs of society and the students, and nature of the learner. The delineation of general goals to specific instructional objectives is a system of closer and closer approximations in that the goal is first defined more clearly in light of the nature of the content; next, judged in light of what is possible with the targeted learners; and thirdly, what is possible within the resources, time constraints, and instructional strategies. An illustrative example of this process provides a closer approximation of the reality.

A general affective goal listed by many science educators is that

> the middle school science program should develop in students appropriate science attitudes, interests, aesthetic awareness, values, and appreciations.

Such a statement sounds good, but it is loaded with various ambiguities and weasel words; e.g., "appropriate." What are appropriate science attitudes, values, interests, and aesthetic awareness and appreciations? The classroom teachers must attempt to clarify the ambiguities and define the weasel words utilizing their understanding of scientists and of the scientific enterprise. An exploration of the nature of science, scientists, and science education suggests unique affective attributes for science; i.e.,

a) curiosity to question and persevere in seeking solutions;

b) adaptability to change, a willingness to expect and accept scientific change;

c) tolerance of divergent points of view;

d) reservation of conclusion making and value judgment until data have been considered;

e) an acceptance of uncertainty or error;

f) an appreciation of logical, rational, critical, analytical inquiry;

g) critical analysis of claims based on superstitions;

h) constant search for cause-effect relationships;

i) realization that science is not capricious and that human understanding and perceptions of truth may change but the actual event and/or relationship is constant; and

j) awareness, appreciation, and value of science, scientific relationships, limitations, and applications related to contemporary science issues.

Each of these affective attributes appear to be legitimate in terms of the nature of science, but further screening, considering the societal and nature of the learner factors, provides additional validity and priority to the attributes.

The specific learning characteristics of the target population, such as middle school students, make it unrealistic to attempt certain of the affective outcomes. Specifically it may be optimistic to stress objective (i) dealing with the noncapricious nature of science, while middle school years appear the appropriate time to focus on objective (e), the uncertainty and error involved in science.

Klopfer (1976) suggested that affective objectives can be specified in behavioral terms in the same manner as can cognitive objectives. Klopfer suggested the use of a content-behavior matrix similar to that which Tyler (1950) used to organize specific objectives. The content-affective behavior matrix requires a third dimension nested within each major content-affect cell which represents the level of behavior. Klopfer has taken the hierarchical affective behaviors [that is, receiving, responding, valuing, organization, and characterization by a value complex (Krathwohl et al., 1964)], and visually indicated the internal hierarchy using the matrix. Table 2 illustrates the potential aids of Klopfer's grid when writing affective objectives, such as:

> *The student will receive science events related to uncertainty and error.*

Therefore the set of six (6) objectives 1.2, A.1; 1.2, A.2; 1.2, A.3; 1.2, B.1; 1.2, B.2; and 1.2, B.3 represent a hierarchical continuum of the affective objective dealing with the error and uncertainty of science. The Klopfer technique can be used to more clearly specify affective objectives which decrease the ambiguities, increase the planning potential, and increase the accountability potential.

Similar grids using cognitive taxonomy and science content, motor skills and science area or scientific processes, and science area as dimensions can be a useful mapping technique to assure all goals are appropriately delineated. Issues such as which science area is best equipped to clearly illustrate specific objectives can be considered using such a grid approach. Summary grids for yearly science objectives can clearly demonstrate goals omitted or overemphasized.

SELECTING AND FORMULATING APPROPRIATE LEARNING ACTIVITIES TO ATTAIN SPECIFIC INSTRUCTIONAL OBJECTIVES

> This [individual student differences] places considerable responsibility upon the teacher, both to set up situations that have so many facets that they are likely to evoke the desired experience from all the students or else the teacher will vary the experiences so as to provide some that are likely to be significant to each of the students in the class. The problem, then, of selecting learning experiences is the problem of determining the kinds of experience likely to produce given educational objectives and also the problem of how to set up situations which will evoke or provide within the students the kinds of learning experiences desired (Tyler, 1950, pp. 64-65).

Content	Behavior					
1. Error and Uncertainty in observing and measuring events i. the Natural World.	A. Receiving			B. Responding		
1.2 Physical events	A.1 The student is sensitive to observation and measurement errors and uncertainty in inferring.	A.2 The student is inclined to note range of measurements and inferences.	A.3 The student carefully attends to measurements made on the same object or inferences based on the same data.	B.1 The student will make multiple measurements and inferences when told to do so.	B.2 The student will volunteer to make multiple measurements or inferences.	B.3 The student will express a higher degree of certainty for an average measurement based on five (5) measurements

Table 2: Content-Behavior Grid

Jaus (1977) and Shymansky (1978) suggested that student-centered activities are appropriate for middle school-aged students. They found that student-centered activities tended to increase cognitive achievement and creativity. Generally, research indicates that no one form of instruction is the best method to teach science. It is presently believed that certain activities and methods are better equipped than others to attain specific objectives with specific types of learners. Compatibility between outcomes, learners and methods, selecting activities that actually fulfill their claims, and developing activities that integrate the middle school curriculum are major concerns when selecting and formulating learning activities for middle schools.

The 30-year-old concern expressed by Tyler is as current today as it was when Tyler wrote it. Too often both objectives and activities are determined by writing down a catalog number of a published science textbook or program. The middle schools have a great opportunity to avoid these traditional shortcomings, since few commercial programs fit the grade groupings of the middle school. Therefore middle school science teachers are forced to select and develop materials from a variety of sources. Tyler (1950) outlined several guidelines for selecting activities:

1) Attainment of specific objectives requires student experiences that provide practice of the specific behavior described in the objective and the experience must involve the type of content specified in the objective.

2) The terminal behavior must be satisfying and therefore motivating to the student.

3) The terminal behavior must be within the capabilities of the student.

4) Appropriate alternative experiences are possible for each objective.

5) Any given learning experience may initiate behaviors not specified by the objective.

Tyler's selected guidelines blend together delineation of objectives and selection of activities. Generally, learning experience criteria need to consider (1) the target objective(s) and (2) the attributes of the target learners. The degree of clarity possessed by the objectives is directly related to the ease of considering the target objectives.

Compatibility

The key question is to select or develop inquiry strategies or other activities that capitalize on the learners' assets and help develop new logical skills, knowledge, processes, and attitudes. Morine and Morine (1973) outlined five unique inquiry strategies which may be compatible with specific groups of middle school students attempting to attain specific science objectives (Table 3).

The classroom teacher must select and develop appropriate strategies which will be compatible with the learner, the subject, and identified outcomes to maximize effectiveness. The nature of science dictates that learning experience should be an active attempt to search out, describe, and explain patterns of events in our universe. Therefore, by necessity, reading and talking about science should play a minor role in appropriate science instruction. Many middle school science curricula stress the attainment of concepts and development of science processes, skills, and attitudes. The active search for content, process, skills, and attitudes is to be carried out by a group of learners that spans the concrete operational and formal operational stages of cognitive development. Shymansky and Yore (1980) explored the concrete-operational/formal-operational transition and found that formal-operational students could handle the hypothetico-deductive teaching/learning strategy more effectively. Shymansky and Yore also found that a student's ability to locate an embedded figure in a complex background (field independence) was related to success in unstructured inquiries.

Open Inductive. The unstructured nature of the open inductive strategy does not preclude the attainment of concepts, but rather allows for diversity of concepts attained. The main goals of this approach are (1) development of prerequisite conceptualization processes (observing and classifying) and (2) enrichment of the learner's experiential background. Traditional learning activities, like field trips, miscellaneous collections, and classifying bolts and nuts, can be meaningful open inductive experiences for middle school students. Data, such as popsicle sticks, leaves, rocks, minerals, twigs and other things collected on a nature hike, can provide a concrete foundation on which to develop observation, classification, and ordering skills. The specificity, amount, and commonality of data across all learners are of limited concern in the open inductive approach. The critical factor related to data is the concrete nature of the experience. Morine and Morine (1973) suggested that in the open inductive strategy the teacher consider using (1) limited amounts, (2) complex, (3) diverse, and (4) unfamiliar data, and encourage (5) open-ended method of observation, and (6) diverse organization of the data. These factors will tend to increase the diversity of the learner's experience while maximizing the mastery of the conceptualization processes.

Type of Discovery (inquiry) Lesson	Appropriate Discipline	Type of Thinking Utilized by Student	Cognitive Development Required of Student	Primary Outcomes
Open inductive	Biology & earth sciences	Inductive	Concrete stage (ages 6-11)	Process (categorizing)
Structured inductive	Biology & earth sciences	Inductive	Concrete or formal stage (age 8 and beyond)	Content (concepts, categories, generalizations)
Semi-deductive	Mathematics & physical science	Inductive	Concrete or formal stage (age 8 and beyond)	Content (properties, concepts)
Simple deductive	Mathematics & physical science	Deductive	Formal stage (age 11 or 12 and beyond)	Content (conclusions derived from basic premises)
Hypothetico-deductive	Mathematics & physical science	Deductive	Formal stage (age 11 or 12 and beyond)	Process (hypothesis formation and experimentation)

Table 3: Compatibility of Nature of Learner, Subject Area, Outcomes, and Inquiry Teaching Strategy (adapted from Morine and Morine, 1973).

The learner should be encouraged to fully observe each object using as many senses as advisable. The student should then be encouraged to continue developing his/her observing skill sequentially by using two or more senses simultaneously, noting changes, using quantitative statements, and making comparisons. Once rather complete observations have been produced, the learners should be encouraged to group the objects according to similar characteristics. The teacher's questioning should guide the learners to explore multiple ways to group data.

Structured Inductive. A structured inductive inquiry strategy is a high-teacher-structured lesson directed at attaining concepts, categories, and generalizations in a descriptive body of knowledge using inductive thought (Morine and Morine, 1973). Inquiries into biological problems by concrete operational learners within a learning environment that is structured and defined by the teacher illustrate an appropriate interpretation of a structured inductive inquiry lesson.

Lesson structure can be accomplished by varying the amount, complexity, diversity, introduction, and organization of the manipulative materials and lesson. Examples are used to initiate a category, followed by counter examples to encourage restructuring of the category. The new category can be reinforced by confirming examples and nonexamples or restructured by additional counter examples. Examples of these factors used in a structured inductive strategy are illustrated in Creature Cards (ESS, 1974), Weeple People (Gillespie, 1971), and Color-Weeples (Gillespie, 1972). Examination of Creature Cards numbers 1 and 12 illustrate the value of the structured inductive approach (Figure 6).

The objectives of these activities are: (1) attainment and (2) application of specific concepts (Gligs and Norleys), (3) analysis and (4) mastery of the concept attainment processes. Creature Cards is an excellent initial lesson to illustrate concept formation, attainment, and application, even though the content attained consists of nonsense concepts. Note that the organization of the data allows the learner to search within the example group for commonalities, then to search between groups (example and nonexample) to verify his findings in terms of necessary and sufficient conditions, and finally to apply his attained concept in a unique situation. The teacher's role is to guide the learner's attention to consider unnoticed data. As the learner considers additional data, misconceptions will be judged invalid and revised to reflect the new findings.

The substitution of realistic examples and nonexamples into the structured inductive organization could be used to attain

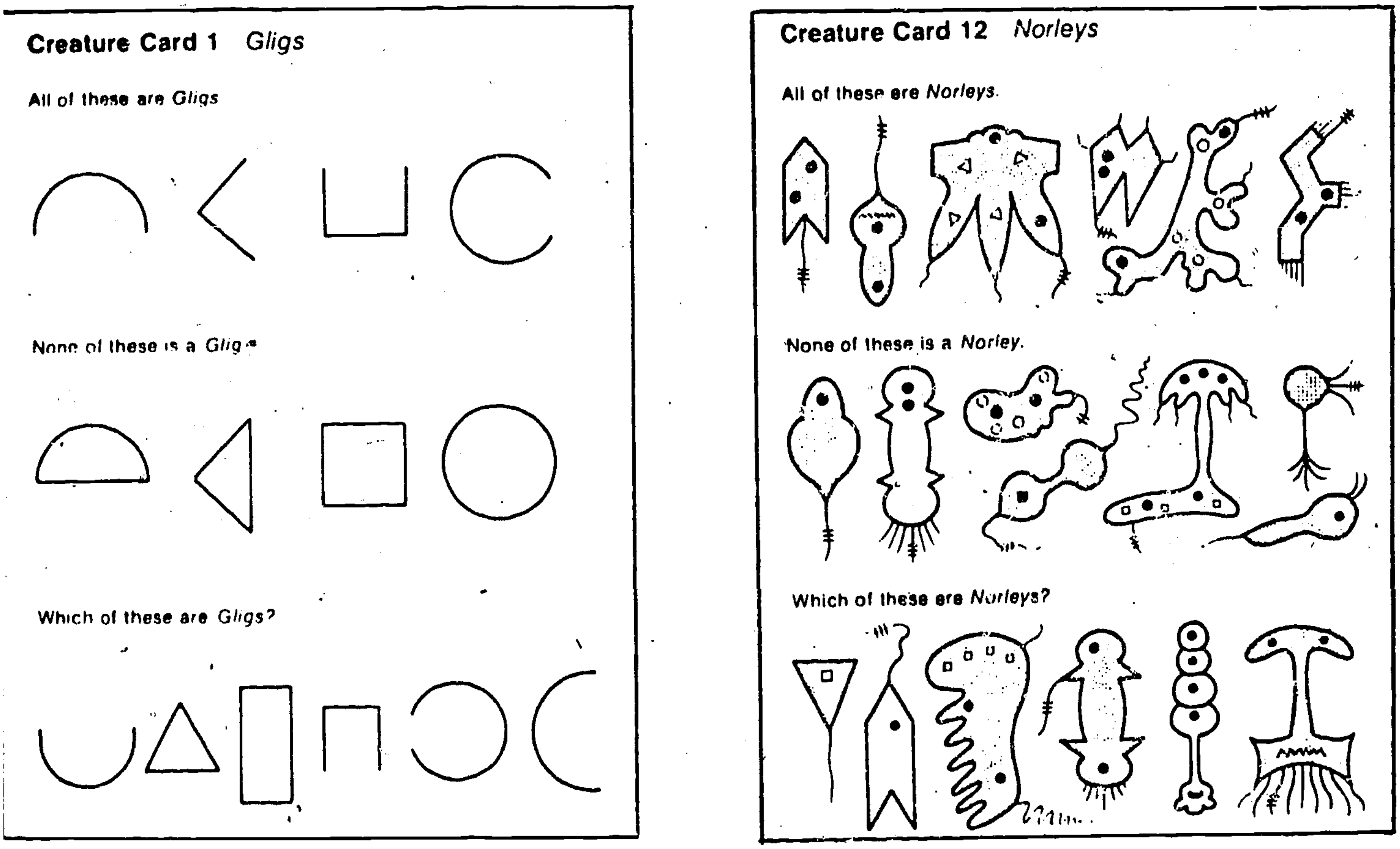

Figure 6: Structure Inductive Inquiry: Creature Cards

such concepts as plant, living, mineral, etc. Other interesting spinoffs might be in social studies, where students explore the formation, attainment, and application of misconceptions (stereotyping) such as Yank, Canuck, Polack. When children learn to correctly attain concepts, misconceptions related to a person's birth and citizenship will less likely occur.

Semi-deductive. When the concept desired falls within the boundaries of the physical sciences, the teacher should choose a semi-deductive strategy. In this case the teacher's major responsibility lies with the selection of appropriate terminal objectives. The objectives must fall within the limits of the learner's capacities and need to be based on concrete experiences.

A semi-deductive inquiry strategy requires little teacher structure; rather, it relies on the structure of the prescriptive content area being investigated to guide the learner's explorations. In discussing this strategy, Morine and Morine (1973) state that a

> semideductive discovery lesson is unique in that [learners] are thinking inductively in a deductive system. They arrive at rules or properties by observing specific data rather than by constructing deductive chains of statement, as the theoretician might. (p. 86)

Morine and Morine assume that since the learner is required to think inductively, concrete operational development will produce successful achievement for semi-deductive inquiries into properties and relationships in the physical sciences. The learning environment should be rich in manipulative materials related to the concepts under investigation and will be structured by the underlying laws and theories related to the concepts. Morine and Morine (1973) contend: "it is [easy] to develop teaching materials for this type of lesson... since selection and organization of data is not so crucial" (p. 87).

Simple Deductive. The simple deductive teaching/learning method, commonly known as the Socratic method, is not new. This approach attempts to get students to deduce specific facts from, or inconsistencies between, generalizations. Such deductive mental activities will require formal operations. Therefore, simple deductive inquiry generally starts with a stated generalization and the inquiry is generally designed to validate or apply the stated generalization.

Weather forecasting is a topic which naturally lends itself to the simple deductive approach. Such a topic normally occurs near the end of a weather unit in which the students have already developed a basic comprehension of weather elements and patterns.

Armed with these generalizations, students could easily be encouraged to predict (deduce) future specific weather conditions for a location knowing the existing conditions for the general region.

Hypothetico-deductive. The hypothetico-deductive inquiry lesson requires the students to utilize deductive thought, generate hypotheses, make predictions, design experiments, control variables, and interpret data (Morine and Morine, 1973). A hypothetico-deductive approach is appropriate for formal operational students exploring a well-developed deductive body of knowledge to develop deductive inquiry skills. The classroom organization should parallel the hypothetico-deductive model mentioned earlier. The hypothesis generation phase develops around free, unstructured messing around with the materials or, if the event was judged to be part of the students' background, this phase may be omitted. The problem may be set using a live demonstration which surfaces many of the variables involved in the phenomona. As a direct spinoff of the messing around and demonstration, students formulate the hypothesis. A complete discussion of the dependent and independent variables follows, with consideration given to other variables not mentioned.

The deduction phase can be operationalized by having the student generate two sets of graphic predictions of expected outcomes based on the assumptions that (1) the hypothesis was true or (2) the hypothesis was false. The use of graphic predictions simplifies the latter process of interpreting the data.

Experiments are then designed by groups of individuals to test the hypothesis. Further consideration may be given to techniques for measuring or observing the dependent variable, schedules for varying the independent variable, and methods of controlling other variables.

The designed experiments are then carried out to collect observations or measurements. The resulting data are organized and graphed, and graphs are compared to the graphic predictions. A decision reflecting the goodness-of-fit of the observed data and the predictions based on the hypothesis being true or false allows the students to decide whether the observations support their original hypothesis or they need to reject and revise it.

Assessing Activities

Existing activities, programs, and teacher-developed activities need to be assessed to assure that the activity is actually what is claimed or intended. Butts and Ricker (1977) pointed out that program selection should consider established specific objectives, student resources, teacher resources, and physical resources. Butts and Ricker provided a series of focus questions to guide such an assessment, specifically:

Student Resources

1. Does the program fit the students' past experience?

2. Does the program fit the current performance level of the students?

3. Does the program enable students to use their immediate environment to pursue new science achievements?

Teacher Resources

1. Does the program provide a clear outline of its content or structure for a teacher?

2. Is [there] a list of what students should be able to do with the content given--a list of objectives?

3. For each objective, is an example of a test or assessment item included?

4. For each objective, are there alternative learning activities?

5. Is there a chart showing the relationship between objectives, test items, or assessment, and learning activities?

6. Is the time-management outline clear to help a teacher know which activities need to be scheduled when, and what preparation the teacher must make? (pp. 18-19).

Renner and Phillips (1980) suggested an analysis of "the reasoning required...to understand a concept is... [a] model [that] can be used as a paradigm to select and evaluate content" (p. 195). An analysis of the reasoning required will assist in determining whether the logic demands are appropriate for middle school students. Inappropriate demands (i.e., excessive deduction or hypothetico-deductive reasoning) can generally be revised to require induction by simply changing the order of events. "The principle of matching content with the type of thought learners can use in order to promote concept understanding and not just memorization" is critical (pp. 196-197).

Fuhrman (1978) used a system [developed by Tamir and Lunetta (1978)] to analyze secondary science laboratory activities. She determined the inquiry behaviors actually required by a variety of chemistry laboratory manuals. The results indicated that laboratory activities were a central part of the programs investigated, but that many activities followed the textual discussion of the concept. Students were limited in their opportunity to identify problems, formulate problems, formulate hypotheses, make predictions, or design observation and measurement procedures. A modified Laboratory Analysis Inventory (LAI) can be helpful for middle school science teachers' systematic evaluation of laboratory activities. Tafoya et al., (1980) developed a similar checklist system for assessing inquiry potential. The checklist helps provide systematic information that can be used to determine whether the activity does what it claims.

A conscious effort must be made to develop, assess, and evaluate learning activities in terms of the stated objectives and of the targeted learners. A checklist designed around Butts and Ricker's focus questions is a worthwhile tool for middle school science teachers. Compatibility is more likely to occur if teachers are explicitly aware of the objectives, student resources, teacher resources, and physical resources.

INTEGRATION OF SUBJECT AREAS IN THE MIDDLE SCHOOL: A FINAL WORD

The lack of traditions in the middle school, semi-departmentalized structure, and teachers' backgrounds are several factors that increase the probability of integration across content boundaries. The middle school is relatively young and is not case-hardened by a long history and traditions. Many middle schools use self-contained classrooms in the morning and departmentalized specialties in the afternoon. The semi-departmentalized structure requires that each teacher teach a common core of subjects and their specialty subject. Many teachers initially attracted into the middle school have elementary education backgrounds with a reasonably strong teaching area. The combination of the lack of tradition, semi-departmentalized timetable, and generalist teacher training helps fade the content boundaries and allow a dovetailing of topics in the middle schools. The following examples are activities used with middle school-aged students.

Science of Sport

> Sport performance obeys the physical laws of nature even though some performers appear to defy these laws. Athletes knowingly or unknowingly utilize laws of mechanics to accomplish impressive performances. Force, energy, momentum, mass, work, and time are manipulated and skillfully synchronized to maximize speed, distance,

and beauty. Debbie Brill, Nancy Greene, Karen Magnusson, Phillip Delasalle, and the weekend athlete all attempt to weave science and art into their physical performance (Yore and Carr, 1980).

Activity 1: Analyzing Sport Performance Films (Larry Yore).

Problem: The following activity is designed to illustrate potential uses of science in sports.

Materials: Film, videotape, pictures.

Procedure:

1. View the films provided of specific athletic events.

2. Analyze the performance in terms of the scientific laws, principles, and concepts utilized and illustrated. The analysis should use the index of mechanics concepts provided. Feel free to draw diagrams or do a personal demonstration of the critical aspects of the performance (see Scientific American, March 1980, pp. 154-164).

3. Compare the historical styles used in the sport event.

4. Predict what future world records might be or make suggestions how your own performance might be improved.

Activity 2: Shot Put (Ray Rogers, North Saanich Middle School).

Problem: How do the variables of mass and angle affect the distance which you throw a shot put?

Materials: Shot puts (6, 8, 12 and 16 pounds), angle sticks (0°, 15°, 30°, 45°, and 60°), measuring tapes, and graph and data paper.

Procedure:

1. Take three trials with each of the 6, 8, 12, and 16-pound shots, making sure your arm follows the angle of the angle stick which your partner is holding.

2. Record your distance for each trial and shot put.

3. Repeat Steps 1 and 2 with different angled angle stick.

4. a) On the graph paper provided, graph shot put mass (X axis) vs. average distance (Y axis).

   b) On a second sheet of graph paper graph release angle (X axis) vs. average distance (Y axis) for a single shot put.

Activity 3: Running Velocity Lab (Larry Yore and Ray Rogers).

Problem: Investigate the velocity of your arm movement and center of gravity while running.

Materials: Masking tape, ticker tape, yardstick, electric timer (PSSC type), and graph and data paper.

Procedure:

1. Set up two electrical timers with a 10 m ticker tape running through them.
2. Attach one of the tapes to the back of your shorts and the other tape to your wrist, using masking tape or paper clips.
3. Run or walk briskly through the 10 meters.
4. Remove your tapes.
5. Mark tape off in intervals of 10 ticks for the entire length.
6. Measure the length of each 10-tick interval in centimeters.
7. Graph the arm data and the body data on the same graph in different colors. Put the length of the 10-tick intervals on the Y axis and the number of the time intervals on the X axis.

Science of Music

Many people would suggest that music is totally different from the sciences, but a pipe organ builder is equally respected for his artistic and scientific accomplishments. Both the musician and scientist explore patterns and phenomena of sound within the natural environment. The main difference appears to be the internal constraints each investigator places on the exploration; the musician allows his emotions and personal interpretation to be reflected while the scientist constantly battles to neutralize these factors. Sound produced according to esthetically acceptable rhythmic patterns of pitch and volume is commonly referred to as music. Whether it be the fundamental rhythm of calypso, the feverish beat of rock-and-roll, or the basic chords of country western, the common denominator is the laws of science describing sound, its production, amplification, and transmission. The following list of topics outlines a sound unit which integrates science and music.

Lesson	Description of Activity
1	Explore a variety of music and musical instruments.
	a) type of music; i.e., popular, classical.
	b) music production; i.e., electronic, natural.
	c) musical instruments; i.e., piano, pipe organ, trombone, stringed instruments.
2	Vibrating objects, sound production, and characteristics of sound.
	a) Frequency indirectly related to length (ruler/saw blade or pendulum activity).
	b) Amplitude -- loudness.
	c) Frequency -- pitch.

Lesson	Description of Activity
3	Sound perception by humans and other animals.
	a) School nurse -- hearing test.
	b) Oscilloscope -- microphone demonstration.
	c) The Human Ear (<u>Sight and Sound</u>, Health Activities Program (HAP), SRA).
4	Sound and waves.
	a) Rope or coil spring.
	b) Examining a phonograph record.
	c) Frequency is indirectly related to wavelength.
5	Resonance and natural amplification.
	a) Pop bottle organ or resonance apparatus.

b) Column length is directly related to wavelength.

c) Examine a pipe organ or trombone.

6 Vibrating strings.

a) Tension is directly related to frequency.

b) Diameter is indirectly related to frequency.

c) Length is indirectly related to frequency.

d) Composition makes a difference.

e) Examine a guitar (string characteristics, tension, length, and resonance).

7 Analyze modern and ancient musical instruments, i.e., xylophone, trumpet, drums, etc. (Consult music specialist as resource person.)

8 Build a musical instrument [Musical Instruments; (TPS), Lively Craft Cards (Mills and Boon), Musical Instrument Recipe Book (ESS), and Whistles and Strings (ESS)].

Lesson	Description of Activity
9	Class performance on homemade instruments. (Consult music specialist as guest conductor.)
10	Examination.

Unit Resources

ESS, Whistles and Strings (McGraw-Hill).

ESS, Musical Instrument Recipe Book (McGraw-Hill).

TPS, Music Instruments (MacDonald).

Williams, P. Lively Craft Cards: Making Musical Instruments (Mills and Boon).

Griffiths, R. "Making Musical Instruments as a Springboard to Science and Math Integration," Science and Children, November/December, 1975, pp. 7-10.

Griffiths, R. "Make An Aeolian Harp," Children's Digest, September, 1979, pp. 36-38.

Folklore--Fact or Fancy

A culminating activity which integrates science, social studies, and language arts is the analysis of folklore related to weather. The intent of this activity is to illustrate that science is a common human endeavor that attempts to describe patterns of events. The activity is initiated by requesting that students talk to their parents, grandparents, or neighbors to locate an old saying, poem, or limerick which is used to predict the weather. Once the students have located a piece of weather folklore, they are to investigate their saying and determine if the folklore is based on science fact. The investigations may take a variety of paths, such as correlational study of the factors mentioned in the folklore, interviews regarding the folklore with knowledgeable people, and theoretical analysis of the folklore using previously acquired science concepts.

The following folklore have provided a great deal of interest and motivation for middle school-aged students:

> The number of chirps of the black cricket in
> 17 seconds plus 40 will give you the tempera-
> ture in degrees Fahrenheit.

> Rainbow in the morning
> Sailors take warning.
> Rainbow at night
> Sailor's delight.

> When the sun is in his house
> It will rain soon.
> The bigger the ring
> The nearer the wet.

> When the cow scratches her ear
> It means a shower is near;
> But when she thumps her rib with her tail
> Expect thunder, lightning and hail.

Activity Resources

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CHAPTER VII

DEVELOPING PROGRAMS IN MIDDLE SCHOOL SCIENCE

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Biological Sciences Curriculum Study
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In March, 1971, the Biological Sciences Curriculum Study (BSCS) initiated a new curriculum development project--The Human Sciences Program--that differed markedly from most curriculum development projects. The purpose of the project, supported by a grant from the National Science Foundation, was to design, develop, implement, and evaluate an entirely new science curriculum designed for middle school students. The physical, cognitive, social, and psychological characteristics of 10- to 14-year-olds were to be a prime consideration. The program would need to be flexible in structure so as to be useful in a variety of types of classrooms.

Four fields of knowledge were viewed as essential in developing a design for the three-year curriculum: characteristics of the learners, major societal trends, teachers and schooling, and the natural and social science disciplines. An extensive literature search, observations and interviews of early adolescents and teachers, and recommendations from a large number of educators and natural and social scientists were a part of the needs assessment and early phases of the project. A synthesis process involving these four fields of knowledge was used to develop a conceptual framework for the curriculum. Hurd, in a recent article (1980), describes how syntheses processes can be applied to developing a curricular framework.

Characteristics of Middle School Learners

Several critical characteristics of 10- to 14-year-olds were considered important for the curriculum design. Jean Piaget's theory of cognitive development provided a useful heuristic for designing learning activities. From Piaget's perspective, intellectual development is attributed to the interaction of three processes: biological maturation of the child or adolescent, experience of the child or adolescent with the physical and social environment, and social interaction, the verbal stimulation received from parents, teachers, and others (Inhelder and Piaget, 1958). The Human Sciences Program was designed in a deliberate manner to accommodate these three components of intellectual development.

Physical variability is a significant learner characteristic in early adolescence. Such variability can provide relevant subject matter for study. Understanding of and appreciation for variation in life forms and in behavior of organisms was identified as a program level objective (Objectives in Human Sciences, 1979). The Human Sciences Program provides many opportunities for students to gain knowledge about human growth and development in general and their own growth and development in particular. Students are encouraged to develop positive attitudes about such things as

--the inevitability of continual change as a part of the life experience;

--individual differences in patterns of physical growth;

--sex differences in patterns of physical growth.

In personal development, 10- to 14-year-olds are largely egocentric, viewing objects and events in personal terms. Hobby interests are widespread and varied. Students are concerned with doing and building, with conquering small bits of the environment. White (1972) finds that persons in this age group seek to develop competencies by being actively engaged in dealing with both the inanimate and the human environment. Erikson (1959) points out that the individual at this age "develops industry, that is, he adjusts himself to the inorganic laws of the tool world. He can become an eager and absorbed unit of a productive situation. To bring a productive situation to completion is an aim which gradually supersedes the whims and wishes of his idiosyncratic drives and personal disappointments" (p. 86).

The Human Sciences Program was designed to include opportunities in a wide variety of contexts for psychomotor skill development. Manipulation of materials and equipment, construction of models, and other "hands-on" experiences are the basis of many concrete learning experiences in the program. Such learning experiences are viewed as prerequisites to the formulation of scientific concepts and also as valuable learning experiences in themselves.

The Human Sciences Program assumes that the cognitive and affective dimensions of life, and of learning, are interrelated. Educational programs should provide experiences involving students' total personal development. Information and knowledge are not acquired in a vacuum but involve the learner's feelings, emotions, values, and interpersonal relationships with others. Affect is not a simple quality, but embraces a range of interdependent meanings related to "feeling" and "valuing." The personalized and interdisciplinary nature of Human Sciences encourages a learning environment rich in daily experiences of

--listening to others,

--accepting others' viewpoints,

--identifying and becoming aware of one's own feelings,

--expressing one's own feelings,

--becoming aware of the feelings of others,

--identifying and becoming aware of one's own values,

--expressing one's own values,

--becoming aware of the values of others.

For most middle school students, by the seventh or eighth grade the peer group becomes very important. Thus, the social context of learning cannot be ignored. By working in pairs or small groups in the classroom, the development of social competencies is encouraged. Students collaborate in nurturing plants and animals, carrying out experiments, interviewing peers and adults, and in arranging special projects. Rather than discouraging communication, science programs for middle school students should encourage task-related oral communication with a variety of persons and in a variety of situations. Such social interaction is a necessary ingredient of intellectual, as well as social, development.

Major Societal Trends

The fundamental context for any curriculum project in the United States is the web of basic tenets of a democracy. These include such things as

--deep concern for the individual;

--faith in equality of opportunity;

--belief that citizens are capable of skilled decision-making about issues relevant to their own personal lives as well as to general societal well-being;

--belief that each person is capable of self-improvement, self-direction, and self-discipline.

If one makes the assumption that public educational institutions have a responsibility to help develop effective citizens, it seems appropriate that schools should include opportunities for developing self-direction in learning and skill in decision-making. The ability to make intelligent decisions in the context of a complex and changing society requires the skill of learning how to learn. This skill, or perhaps more accurately stated, cluster of skills, is based on the recognition that life is a self-initiated, life-long, do-it-yourself learning project involving many decisions and choices.

Self-directed learning can be defined as giving students opportunities to learn

> how to choose _what_ is to be learned, _how_ it is to be learned, _when_ it is to be learned, and _how to evaluate_ their own progress. Students need to learn all this in settings which provide for the active assistance and cooperation of teachers and other adults, and of their peers. (Della-Dora and Blanchard, 1979, p. 1)

The developers of the Human Sciences Program have created a program in which students are given opportunities for developing decision-making skills and self-direction within a structured situation. As Don Wells so aptly states:

> FACT: During early adolescence the development of control over one's life through conscious decision-making is crucial.
>
> RESPONSE: Adults make all meaningful decisions for almost all early adolescents almost all the time...
>
> FACT: Early adolescents need a distinct feeling of present importance, a present relevancy of their own lives now.
>
> RESPONSE: We place them in institutions called "junior high school" which out-of-hand stress their subordinate status to their next maturational stage, and then feed them a diet of watered down "real stuff"... (Lipsitz, 1977, pp. 83-84)

The developers of the Human Sciences Program decided to create a program that provided responses more in keeping with the "facts" as identified by Wells. The field test of the Human Sciences Program was carried out under the following conditions:

1. After an introduction to whatever materials were available (a "cluster" of several activities, a "problem area" of 10 to 15 activities, or a "module" of 27 to 45 activities) students were generally free to choose

--what activity to do;

--whether to work alone or with one, two, or more other persons;

--how long to pursue a given activity;

--whether to develop extensions to the basic educational experience ("going further").

2. Students were responsible for some form of record-keeping and accountability in terms of use of time and choices made.

3. Students participated in a variety of evaluation tasks, some of which involved self-evaluation ("self-hecks").

4. Students were responsible for handling (and, sometimes, procuring) of material resources necessary to complete activities.

5. Students were often involved in group problem-solving or decision-making sessions involving scarcity of resources, interpersonal conflict, and use of the local community as a resource.

Teacher, student, parent, and administrator feedback about the program has consistently indicated that this self-directed component of Human Sciences is a valuable feature of the program. While schools, classes, teachers, and individual students varied in the way decisions were made and problems solved, for the most part, response to the opportunities presented was very positive.

Another societal trend that should be kept in mind in present science curriculum projects is the interface of science, technology, and society. For almost two centuries, science and technology have changed the contours of human life. Science education for the '80s should in part be "technology education." However, the interrelationships among science, technology, and society are complex. It is difficult to know how to develop curriculum materials that deal with these relationships. Yet some efforts are being made to do so (Science, Technology, and Society, 1980).

The Human Sciences Program attempts to deal with some aspects of technology appropriate for middle school students in the INVENTION module. In this module, a number of inventions, both "old" and "new," are topics of activities. Five general questions about each invention are addressed.

--How does it (the invention) work?

--How is it important to me?

--How is it important to others?

--What has been its past?

--What will be its future?

Teachers and Schooling

A third element which must be considered in developing curriculum programs is knowledge and assumptions about teachers and schooling. In the Human Science Program the role of the teacher is primarily that of a facilitator. The Human Sciences teacher is encouraged to

--work cooperatively with students, administrators, and parents in support of the common enterprise of learning;

--use most classroom time interacting with individual students or small groups of students rather than with the class as a whole;

--develop a style of questioning that helps individual students solve common classroom problems, reflect on their learning experiences, make rational choices, and become aware of their own values and the values of others;

--be actively involved in what is occurring in the classroom in a responsible adult guidance role-neither authoritarian nor "laissez-faire" (The Program Teaching Guide, 1979).

As students learn to manage the classroom environment, the teacher becomes free to interact with students on substantial issues rather than on management. The goal for the teacher is to facilitate student growth--cognitively, socially, personally--and to encourage development of problem-solving and decision-making skills.

Any educational program is based on assumptions about learning. Human Sciences developers have assumed that learning is personal and occurs through direct experience, through reflection on experience and its representation in language. In short, learning must be done by the learner. Therefore, learning activities should, wherever possible, be direct rather than vicarious in nature. Students should have many opportunities to collect data, to organize their experiences in ways meaningful to them, and to design ways to present their ideas and conclusions to others through a variety of forms of communication.

Another assumption of the developers was that for 10- to 14-year-olds learning is best promoted in an interactive context. Human Sciences materials and strategies make the classroom a community in which learning goals are realized as social competencies are developed. Students, working in pairs or small groups, have many opportunities to consider another person's point of view, both in resolving problems regarding classroom use of resources and in small group discussion of substantive issues and problems contained in the activities themselves. Social skills of listening, negotiating, cooperating, being empathetic, planning, and organizing are encouraged. Such skills are important in themselves, as well as in stimulating cognitive development.

Individuals are continually involved in choosing, developing, and implementing their own values in real-life situations. Since this is the case, schooling should also include a values component and be as closely related to real-life situations as possible.

The Human Sciences Program was designed to help students grow in their awareness of the role of values in personal and societal decision-making. Day-to-day personal decisions in the classroom involve value decisions. "Yesterday I promised I would work with Ann on an interviewing activity, but now Jack needs me to help with some equipment he's having trouble with. What should I do?" In considering such decisions, students can be helped to

--become aware of their own personal values;

--express them;

--prioritize values when they are in conflict;

--take action based on values;

--become aware of the values of others.

Students also can be helped to become aware that societal decisions, even those that seem to be "scientific" issues, also contain a value dimension. Issues involving health care, the environment, and technology, for example, are not likely to be resolved without a consideration of values in addition to relevant and reliable knowledge. In studying such issues the role of values in decision-making can be explored. The value pluralism that exists in our society can also be explored.

In order for such issues to be considered effectively a classroom atmosphere of mutual trust between student and student and between students and teacher must be established.

The Natural and Social Science Disciplines

The traditional approach to developing science curricula for early adolescents has been to deal with the question "How can the natural science disciplines be simplified to be within the capabilities of 10- to 14-year-olds?" Traditional topics such as plants, animals, the human body, and topics from chemistry and physics have been utilized as curriculum structure, usually presented in textbook format. The form of most science textbooks is essentially expository. The reading the student will do is essentially exposition of the adult text writer's explanations of objects and events of interest to natural scientists.

In contrast, the middle school curriculum described here does not begin with the question of simplification of science. It begins with the question, "How can the sciences contribute to the development of children as they grow into adolescents?" The content and organization of the curriculum materials does not rely on the organization of biology, chemistry, physics, or sociology. The formal structure of these disciplines requires a level of cognitive development that is attained by very few middle school students. During the needs assessment phase of the program the interest of students in traditional science textbooks was found to be low. Questions of interest to students were found to be interdisciplinary in nature.

As a result of the conceptual framework conferences held at the initiation of the Human Sciences Program, it was decided that a science curriculum for 10- to 14-year olds should relate to developmental characteristics of this age group and should primarily focus on concerns and problems of students. Concepts, principles, and modes of inquiry from the natural and social science disciplines would contribute substance and perspective to the curriculum but not be the basis for its organization. A textbook as the primary student material was abandoned. In order to provide a new framework for content selection a group of "generic questions" and "content themes" was developed.

Generic questions are questions that were derived from studies of student interest and concerns, through analyses of research of developmental tasks, and through interviews with middle school students and teachers. Four generic questions were proposed:

--Why do things change?

--Why do living things act as they do?

--What determines who gets what?

--What is normal?

A second dimension of the curriculum framework initially proposed was a set of three multidisciplinary themes that subsume some major ideas of the natural and social sciences:

--Continuity and change.

--Competition, accommodation, and cooperation.

--Equality and inequality.

A third dimension of the curriculum framework was a series of topics or themes that could be used to bound a finite time period and to provide divisions of a course. These were called modules. The Human Sciences Program consists of 15 modules.

Each Human Sciences module contains from 27 to 45 activities. Level I modules are "smaller" than Level II and Level III modules. The titles of the 15 modules available commercially are given below.

Level I Modules	Level II Modules	Level III Modules
LEARNING	PERCEPTION	KNOWING
SENSE...OR NONSENSE?	RULES	INVENTION
MOTION	SURVIVAL	CHANGE
SURROUNDINGS	REPRODUCTION	FEELING FIT
GROWING	WHAT FITS WHERE?	
BEHAVIOR		

Level I was field tested in the sixth grade; Level II in seventh grade; Level III in eighth grade. Their use is not, however, limited to these grade placements (Human Sciences Program).

As Figure 1 indicates, the balance among the four major groups of disciplines used as sources for the curriculum varies among modules. Some modules themes, such as "change" or "knowing," can draw equally from all four areas; others such as "behavior" cannot do so.

A Human Sciences module is a thematically organized group of activities. An activity is the learning unit common to all modules. Each activity should directly engage the student with an important object or event, should provide practice in a variety of process skills, and should be designed so that the student can easily understand what is to be done. Modules are divided into clusters of activities or problem areas for

Content Sources of the Human

Sciences Program

Content Sources	Level I						Level II					Level III			
Modules	LEARNING	SENSE. . .OR NONSENSE?	MOTION	SURROUNDINGS	GROWING	BEHAVIOR	PERCEPTION	RULES	SURVIVAL	REPRODUCTION	WHAT FITS WHERE?	KNOWING	INVENTION	CHANGE	FEELING FIT
Life Sciences	*	++	+	+	++	++	++	*	++	++	++	+	*	+	++
Physical Sciences	+	+	++	*	*		+	++	+		*	+	++	+	*
Earth Sciences		*	*	++				*			*	+	+	+	*
Behavioral Sciences	++	++	*	+	+	++	++	++	++	++	++	+	+	+	++
Other	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Content Source = +
Major Content Source = ++
Includes Selected Activities = *

Figure 1.

pedagogical purposes. Students have direct access to the materials needed to do activities.

Among the many criteria that the Human Sciences developers set for themselves was that activities should be of interest to 10- to 14-year-olds. In most instances, activities should provide direct or concrete experience with physical objects or interactions of people. Activities may use filmstrips, tapes, pictures, charts, and games, as well as laboratory equipment and supplies. In contrast with a textbook, this design for curricula does not assume that all students can benefit from the same material. Activities are designed at differing levels of difficulty and complexity involving varying modes of learning.

Activities are not provided in quantities for whole class use, except for a few activities that are all-class, teacher-directed experiences. Limited supply means that students, with teacher assistance, have opportunities to learn how to manage scarce resources. It also makes possible a much smaller equipment investment.

An important underlying assumption of the Human Sciences Program is that science consists of two highly interrelated, indeed inseparable, components. The systems of concepts, theories, principles, and laws of science are one component. The methodological principles, the processes of scientific investigation by which the substance of science is developed and validated, are the other. Science curricula for early adolescents should emphasize both components.

The learning activities (some 550 in all) that comprise the Human Sciences Program provide a wide range of opportunities for developing specific science process skills as well as more general inquiry patterns of investigating and experimenting which utilize several specific skills. The Teacher's Guides for each module identify science process skills, as well as communication and coding skills, and personal skills for each activity.

Impediments to Developing Effective Curricula for Middle School Students

The Human Sciences Program required a number of years for development, field testing, evaluation, and revision. During its developmental phase a number of issues emerged.

1) A number of criteria were identified for developers to utilize in development of learning activities. Often in the development of modules and activities it was necessary to prioritize criteria and attend to some and not others. For example, when attempting to develop "hands-on," "involving," "concrete" activities it was not

always possible to create activities which would make explicit the broadly based interdisciplinary themes identified as part of the conceptual framework. Therefore, the commercial edition of the program does not contain explicit reference to these three themes.

2) It is difficult to find people who can develop activities that are interesting to 10- to 14-year-olds and which fit into an interdisciplinary framework. Science teachers, science teacher educators, and scientists are apt to be "trapped" by background, education, and experience into expectations of what middle school students "ought to know." What students are interested in and what scientists, science educators, and teachers think they "ought to know" may be quite dissimilar.

3) The issues and questions students identify as of interest are often considered controversial by some adults. Environmental concerns, relations between the sexes, issues of "should one" or "shouldn't one" are related to real-life adult concerns which may be controversial. The orientation of the program suggests that students can, on a level appropriate to their developmental stages, inquire into such issues. Some people consider students this age as being too young for such activity. One Congressman, for example, took issue with the Human Sciences Program partly because it enabled students to inquire, to ask questions. His position was that teachers should teach <u>the</u> facts, and only <u>the</u> facts, to students. They <u>are</u> too young to <u>inquire</u>, from his perspective.

4) Developmental questions can be raised about a problem or issue-centered multidisciplinary program.

--Can students of this age move beyond a "common sense" response to issues?

--Are real life issues too complex and multi-dimensional for most middle school students' cognitive capabilities and/or interests?

Evaluation of the Human Sciences Program indicates that some of the activities judged as "model activities" by the program's developers and reviewers were not of high interest to students. For example, the "kidney machines" activity in the INVENTION module was a multidisciplinary activity that included the anatomy and physiology of the kidney and how a kidney machine works (in sound filmstrip format); a "hands-on" experiment demonstrating dialysis; and case study dilemmas involving ethical/moral issues related to kidney machines. The activity was well researched and viewed very positively by teachers, parents, and reviewers. Yet students in a free-choice situation rarely chose to do it. In contrast to other learning activities available, it generated little interest. Activities more closely related to daily life experiences of most students--for example, "Shoes," "The Telephone," "Money, Money, Money"--were more often the choice of the eighth graders in field test classes.

5) The Human Sciences Program design assumes that middle school students can construct their own knowledge from carefully designed learning experiences. However, some adults are fearful that youngsters will construct "the wrong answer" in some of their formulations. They forget that not all students understand the texts they read. Students in Human Sciences cannot simply memorize a "right answer" to put down on a quiz or test. This aspect of the program design does bother some teachers and parents. It may also initially bother some students who assume that memorization is the royal highway to academic success.

6) Any nontextbook design is not popular with publishers nor with states that require the adoption of textbooks as basic materials. In spite of this, the publisher of the commercial edition of Human Sciences is keeping the program in its original form of activities and accompanying media and material resources.

7) Any interdisciplinary program suffers from some similar problems and concerns.

--Teachers see it as lacking some favorite and familiar topics and learning activities. Any curriculum program has only so much school time available to it. When something is added, something else must be omitted.

--Teachers are uncomfortable with topics or teaching strategies perceived as unfamiliar. Supporting teacher materials can help alleviate teacher insecurity, but cannot eliminate it.

--Effective interdisciplinary curriculum development and writing teams are hard to come by. Differing backgrounds, education, and work experience produce different views of appropriate learning activities, different value priorities, even different definitions of the "same" term. Much time will be spent in meeting personality needs and in devising ways to communicate together effectively. Development becomes costly in terms of time and money.

8) Under present conditions, means to finance and provide for adequate teacher orientation and education for innovative programs are hard to come by. Programs like Human Sciences, therefore, are rarely fully understood even by field-test teachers. Although HSP field-test teachers had brief orientation sessions, these could address only selected aspects of the program and a few of the learning activities. However, teachers utilizing the commercial materials will usually have no orientation at all, other than that provided by a filmstrip that introduces general aspects of the program, a program teacher's guide, and a module and activity-specific teacher preparation materials. In preparing these materials developers have attempted to anticipate teacher questions, potential trouble spots, and so on. However, such an approach cannot adequately substitute for opportunities to actively work with the curriculum materials in an interactive way with experienced teachers, teacher educators, or the developers of the program.

Some Trends in Curriculum Development

A number of points can be made about curriculum development at the beginning of the 1980s.

1) There is a reawakened awareness of the teacher's function in curriculum development and implementation. Realization that many of the 1960s large-scale curriculum reform projects were not implemented as the developers thought they would be has been one aspect of this awareness.

   Belief that a local district or school curriculum development project can serve as an effective staff development method is another. Many school administrators encourage their staffs to "reinvent the wheel," believing that it is not "the wheel" that is important but the inventing process itself.

Teachers played an important role in the development phase of Human Sciences as members of writing teams, field-test teachers, and staff members. Revision of experimental materials used teacher evaluation and feedback extensively.

2) Dialogue about the value of "externally developed curricula" such as the Human Sciences Program and "user-based curricula," takes a variety of forms (Connelly, 1972; Weiss, 1980). External developers can elaborate theoretical notions of society, teachers and schooling, the learner, and the nature of scientific disciplines. They can then translate these views into carefully designed curriculum materials. Teachers can adapt a program to their particular context. It is naive, however, to expect that classroom teachers should spend their time developing curricula de nová. With some exceptions, they do not have the time, resources, or expertise to perform this role and teach a variety of classes each day. However, teachers can build their own curricula by adapting project materials, such as Human Sciences, to their own classroom needs.

3) Concern over the role of the local district, lay and parent groups, the state, and the federal government in curriculum development has heightened. How to identify the functions that each particular section can best perform is an issue. While there appears to be some agreement that only the federal government has the resources to support major curriculum development programs, there is also belief that curriculum development is a local responsibility and right (Current Issues, Problems and Concerns, 1976, pp. 37-54). In our society, such tensions are not easily resolved.

What Needs to be Done?

Recognition that the early adolescent has been "unrecognized, underprivileged, and undereducated" in the American school system has resulted in a recent emphasis on the need for improved programs for this age group (Hurd, 1979). It has been suggested in a series of recommendations to the National Science Foundation (Hurd, 1979) that "a major transformation in the present curriculum" is needed (p. 55).

Hurd (1979) recommends that such a transformation might result in

--a curriculum that is interdisciplinary in nature;

--a curriculum that is selected for general usefulness in life;

--a curriculum emphasizing process and decision-making skills;

--a curriculum that includes a consideration of values;

--a curriculum that utilizes instructional procedures consistent with the goals of instruction and the nature of the early adolescent;

--a curriculum that utilizes community resources, human and institutional. (p. 55)

A weak knowledge base about the problems of the early adolescent as a learner, and a lack of clarity about the purpose of science education for this age group results in a lack of clear direction about what should be done to improve middle school science education. A variety of needs can be identified.

1) Synthesis studies need to be done that will coordinate the existing data base about early adolescence and science teaching for this age group.

2) Research should be carried out that addresses how middle school students can best learn specific scientific process skills and conceptual knowledge. There is so little known in these fields that adequate methodology may first have to be developed through pilot programs.

3) Exemplary science programs should be identified and materials disseminated so that schools can benefit from the experience of others. The National Middle Schools Resource Center might serve such a function.

4) Evaluation studies of the commercial edition of the Human Sciences Program would be useful in determining the effectiveness of this program in meeting its goals. Since this program meets many of the criteria suggested by Hurd for a "transformed curriculum" for the early adolescent, it should be carefully evaluated in a variety of educational settings. Similar studies of other programs specifically designed for this age group should be carried out.

5) In-service programs designed to re-tool middle school science teachers to adapt programs by "external developers" for local use could be carried out by local districts, teacher centers, state agencies, or colleges and universities.

6) Further consideration should be given to the place of science in the middle school, in relationship to the place of science in general education for all age groups:

--What can most appropriately be taught in the middle school years?

--What can most appropriately be taught in high school or community college?

--What distinctions should be made in developing curriculum materials that deal with

science process skills?

decision-making skills?

logical thinking skills?

knowledge drawn from science as an academic discipline?

knowledge about applied science and technology?

an understanding of the world or world view based on various scientific disciplines (i.e., studying science for its cultural value)?

--Which of the above should be given highest priority in middle school?

In order to most effectively deal with these questions, science educators should join with philosophers and sociologists of science, psychologists, anthropologists, and others to analyze the structure of scientific knowledge and its relationship to societal needs. Out of such dialogue a basic orientation for setting priorities in science curriculum development projects for middle school students might more clearly be articulated.

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CHAPTER VIII

IMPROVING PRACTICES IN MIDDLE SCHOOL SCIENCE TEACHER PREPARATION: THE MEMPHIS STATE UNIVERSITY PLAN

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PURPOSE OF SCHOOLS

Today's schools are being asked to accept more and more responsibility. Educators are being asked to teach everything from learning to count to driver education to death and dying values. As a partial reaction to this growing diversity, the back-to-basics movement is attempting to "rescue" the schools by encouraging teachers to return to a 1940, 3R's curriculum. This rescue attempt places science instruction in the same category as Hindustanian Leaf Contemplation--nice to do late in the afternoon while waiting for the school day to end but not rigorous enough to be included in the three R's, and obviously of questionable value in a student's future life. Science is still offered in the high schools and to a lesser extent in the middle and junior high schools. Elementary schools recognize the need for teaching science; however, in their list of curricular priorities, it usually is identified with art and music--teach it one-half hour each week if you have time!

When science teachers meet, the topic of conversation will eventually focus on the lack of support for science in terms of money available, field trip restrictions, the amount of time in the school day, the poor preparation of students entering their science classes, the inability of students to perform mathematical problems, etc. Behind these concerns and problems is the more basic question--What are schools for?

Using this as a title for his latest book, What Are Schools For?, John I. Goodlad (1980) addresses the purposes of schools based on a research project he conducted in California. He concludes by stating that the education of students of all ages involves the home, the community, and the schools. Each institution should do the job it does best. The major responsibility of the school does not rest with reading, writing, and arithmetic. Goodlad refers to the "lower literacies" as the so-called "basics" of education. These competencies can be learned through available instructional technology and selected, highly skilled teachers who know how to use it. The custodial responsibility of schools could be accomplished in many ways that do not require instruction from prepared, professional educators.

As human beings, we require a certain amount of complexity in our lives. Most students begin to seek new interests and educational challenges after learning "lower literacies." This is where the real value of schools would emerge--to serve that need for more complex learning experiences. These include such needs as successful problem solving, developing sensitive human relations, self-understanding, and the effective integration of one's total life experience (Goodlad, 1980). These needs focus on curricular tasks and activities that include the processes of inquiring, questioning and thinking (reasoning), and forming values about the world. Goodlad's study indicates that we might spend more time studying fewer topics so as to enable students to become more competent in two or three curricular areas. In this way, schools would provide an initial step for some students to pursue areas of interest through their lives; topics would come from the experiences of the learners' lives; and, students would personally identify with their area of study, demonstrating ownership and responsibility for it. Schools should become reacquainted with the structure of knowledge and the ways that we learn. Goodlad emphasizes the need for studying the basic learning concepts through all pedagogic means possible rather than the teacher selecting one means (e.g., laboratory experience, lecture, demonstration, etc.) and letting that suffice for mastering a concept. The learner should read about it, write about it, draw it, dance it, talk about it, touch it, make a physical model, think about it, plan around it, etc. Concepts such as time, number, form, space, conservation offer examples where we can apply these many learning modes.

Science obviously has a significant place in Goodlad's model of schools. The art of questioning, inquiring, and problem solving is inherent in almost all science instruction. Questioning one's environment and his or her ownership for many questions about it encompasses science. Our world today is so science-impacted that it is impossible for a student not to be involved in some aspect of it. The suggested concepts of time, form, conservation, etc., are all woven together through an interdisciplinary science curriculum. The technique whereby the student who chooses to learn science in depth utilizes the learning style that best fits his needs is a more effective technique than one selected from an extrinsic source (i.e., teacher, text, administrator, etc.).

Goodlad also makes the point that teachers should be active practitioners in the subjects they teach. Science teachers would be actively engaged in scientific inquiries as well as teaching them. The art teacher would be a practicing artist; the English teacher would be publishing written works; etc.

Very few educational programs reflect these values. The broad goal of many teacher education programs, as well as individual school systems, is to "prepare students for today's world." In reality, Goodlad's model meets this objective far better than the traditional models utilized by most educational institutions. An underlying rationale for the undergraduate program is a view that science education is undergoing a paradigm shift in its emphasis and intent (see Figure 1). This shift is an attempt to provide the middle school student with a more current view of the nature of science, as well as an acknowledgment of the developmental nature of the emerging adolescent (Hassard, 1980).

An effective science education program reflects the needs of middle school students and teachers, and takes into consideration the question: "What are schools for?" In the following sections a historical perspective of middle school education is presented as a basis for a more current, relevant approach. In addition, the broad goals for middle school science education are presented along with their corresponding implications for curriculum and instruction.

PURPOSE OF MIDDLE SCHOOLS

Middle schools were not generally born of a desire to meet the personal and curriculum needs of the emerging adolescent, but rather were primarily developed as a means of solving pressing administrative or classroom facility problems for the community. The evaluation of the middle school typically grew from the need for communities to construct new facilities to accommodate aging buildings and/or growing enrollments. The decisions to build new schools as well as curricular programs were often based on economic issues rather than those that were educationally sound. Few middle schools were begun with the developmental needs and interests of students in mind. In addition, both elementary and junior high school teachers were moved into the "new" middle school with little or no preparation. The "new" school was usually different from their previous school. However, the students still had the same needs, interests, and problems. The history or background of middle schools is important in preparing teachers. New teachers need to be made aware of the reality of their teaching situation and why it is not always consistent with the theoretical bases for middle school programs.

Today, a new breed of teachers and administrators in middle school education is supporting a rationale which is based on pedagogical rather than economic values. With the interest and support of these individuals, many middle schools now have two different philosophies: a traditional construct which is based primarily on the inculcation of content in preparation for high school, and a more appropriate philosophy which is based on the needs of adolescents during these critical transition years of

The "old" pattern	The "new" pattern
Clockwork model of the universe based on Newtonian physics.	Recognition of relationships and an uncertain universe based on Einstein's physics.
Science is a product--a destination.	Science is a process--a journey.
Science is seen as a single subject with little relationship to art, music, social studies, etc.	Emphasis on relating science to the child's world which is not compartmentalized but transdisciplinary in nature.
Reliance on abstract, theoretical spectator "book" knowledge.	Experiential, participant-observer knowledge complements theoretical knowledge. The classroom is all of nature.
Teacher imparts knowledge, students learn it--one-way street.	Teacher is a facilitator of learning and a learner as well. Networks instead of one-way streets--synergy and interdependence
Content of science is hierarchical and authoritarian in structure.	Content of science is relatively flexible. Belief that there are many ways to learn science.
Emphasis on external world. Learning what is out there. Emphasis on cognition.	Guessing, divergent thinking, and the creative process encouraged and central to the learning process.
Science is taught as a social necessity for a certain period of time, to inculcate minimum skills and content, and to train for a specific role.	Science is seen as part of a life-long process of learning related to schools for awhile, and then integrated with everyday life.

Figure 1. A Paradigm Shift in Science Education.

an individual's life. Because of this dualistic orientation, the scope of the preparation program for middle school teachers is greatly increased. Science education programs need to provide prospective teachers with the means to function in traditional education settings, as well as philosophical-psychological backgrounds to serve as change agents for curricular programs and schools based on the needs of adolescents. These two orientations elicit conflicting learning environments, and therefore the preparation of teachers to function effectively in each of these atmospheres is far more exciting and difficult than in the past.

Science content and processes should be equal partners with other middle school goals. The first goal is to develop motivation for self-direction in learning so that the student is not totally dependent upon the teacher and other extrinsic pressures (i.e., texts, curriculum guides, tests, etc.) for learning. This skill is essential for all students since the ultimate goal of education is to facilitate life-long learning and self-renewal behaviors for each individual. Students learn self-direction through direct experience, which may lead to "incorrect" pathways. However, mistakes with some guidance may provide feedback for the learner.

The second goal for middle school science education focuses on the thinking and reasoning process. Schools strive to help develop the minds of the students, yet very little effort is made by school personnel to understand research data about this process. Less energy is expended in making the science curriculum consistent with these data. Lateral and vertical thinking encourages students at the middle school level to be able to think logically and rationally, as well as to develop their creative ability to think nonrationally. Nonrational thinking can provide an excellent means to introduce new ways to perceive the world. Visual thinking, in addition to lateral and vertical modes, is also an essential skill for the middle school child to learn and develop (McKim, 1980). Most individuals think in words and numbers rather than in pictures and shapes. Visual thinking is part of the creative process, but also relates very closely to rational thinking.

Another goal essential in the middle school is one of interrelating effectively with other human beings. Middle school students value working and learning with other students. These adolescents are becoming more independent and self-directed. Their lives are impacting more on others, especially such adults in their lives as their parents and teachers. Adolescents need to know how their behavior constructively relates to all students, when to seek out others for assistance, how to identify and evaluate choices, how their behavior influences others in ways that are helpful and harmful to themselves, etc. The science curriculum has a role in these processes. Gathering and interpreting data is a process that can be applied to personal situations as well as to scientific ones.

These goals provide a foundation for an individual that can be utilized for all learning throughout high school. In fact, they are the basis for life-long learning that will affect us throughout our lives.

MIDDLE SCHOOL STUDENTS

The Science Education Program for Middle Students in the Department of Curriculum and Instruct.. College of Education, at Memphis State University is evolving from the needs of students and teachers. An effort has been made to select and relate science curriculum materials to the needs and characteristics of middle school students. Research from developmental and cognitive psychologists, as well as from physicians, verifies that students at this level are only on the verge of developing a capability for formal thought. Most traditional as well as new science curriculum programs and textbooks emphasize formal, high-level concepts which often result in curricular programs too difficult for most students.

The program at Memphis State University is an experiential approach, based on the characteristics, needs, and learning styles of adolescents. Specifically, the course of study for prospective middle school teachers centers on three basic characteristics (Adams, 1976). Preadolescents and adolescents generally:

1) respond well to group responsibility and group participation. Students are seeking cooperation and acceptance from their social groups. The opinions of peer groups are becoming more important than the adults in their lives.

2) have a wide range of individual differences and interests. Students do not necessarily want or enjoy having all students in a class work on the same thing at the same time. Also, since students are developing interests in philosophical, ethical, and religious issues they are seeking opportunities to interact and learn in an interdisciplinary format (Kohlberg, 1971).

3) are in a transitional stage in moving from dependence to interdependence. Students are often critical, uncooperative, changeable, and restless. They value cooperative activities which provide opportunities to "try their wings."

Adolescents in a given classroom vary greatly from each other. These differences lie along several dimensions, including intellectual development; preferred learning style (from atomistic to holistic in organizing information); physical maturation; perception of self-worth; levels of competition and/or cooperation; and preferences as to working individually, in small groups, or in whole class arrangements. In order to meet the unique characteristics of this diverse group in a science education setting, it is important to arm the prospective teacher with an array of diagnostic tools so that a more precise picture of class diversity can be drawn before planning for instruction.

There are a variety of assessment techniques and inventories at the disposal of the middle school teacher. Once applied, a very specific student and class profile emerges which facilitates effective instructional planning. Questions as to what curriculum and instructional methods will best match with the student can be answered with confidence when diagnostic information is gathered. The following is a listing of some of the more available and easily administered measures which are presented in the undergraduate program.

1) Piagetian Type Tasks--used to assess levels of intellectual development (Lawson, 1976).

2) The Learning Style Inventory--to assess student learning styles along several dimensions (Dunn, 1975).

3) Self-Concept Scale--to assess the students' perception of worth and self-esteem (Tyrell *et al.*, 1977).

4) Physical Concerns Scale--to assess the students' perception of physical concerns during puberty (Tyrell *et al.*, 1977).

5) Cooperation vs Competition Inventory--to assess the students' perception of willingness to cooperate or compete in learning situations (Johnson, 1975).

6) "Where Do I Fit In" Inventory--to assess students' perception of how they interact within the social millieu of a middle school classroom (Tyrell, et al., 1977).

7) Student Science Interest Inventory--open-ended survey listing potential science topics from available curriculum resources from which students may select science topics of interest to them, and to the class.

It is our experience that a few generalizations can be made about the make-up of the typical middle school classroom. Students at this level have little use for the lecture, didactic format; they prefer active participation during classroom periods; and they do not feel it is necessary to have the entire class involved in the same project at the same time. It is from these qualities that the undergraduate science methods experiences evolve. In the following sections several science education curricula and instructional strategies are presented. They have been selected for presentation in classes because they are consistent with the developmental levels of the emerging adolescent, serve to accommodate middle school students' learning styles, and provide an excellent source for activities that interest students.

MIDDLE SCHOOL SCIENCE CURRICULUM

Prospective teachers, much like adolescents in middle schools, enter undergraduate programs with varied backgrounds in teaching and science. This requires flexible, student-centered courses of study in science education which offer opportunities for exploration, discovery, and application, as well as activities that are appropriate for all these students who, much like the adolescents, are not expected to pursue or achieve the same goals and objectives. However, the instructors have identified generic concepts and skills that are basic for middle school science teacher education; students have the option of selecting the means which best "fit" their learning style.

Specifically, we believe that an effective teacher education program for middle school teachers should contain the following qualities. The science curriculum should:

1) be primarily determined from the intellectual, emotional, social, and physical characteristics unique to early adolescents. Diagnostic procedures such as Piagetian tasks, self-concept scales, and inventories which assess competitiveness, cooperation, and physical growth are utilized by the teacher to facilitate a match of the curriculum to the student.

2) include science topics which come from a variety of sources, including concepts from texts, teacher interest, community needs, and student interest inventories. The selection of these topics is accomplished in a democratic atmosphere, whereby divergence and independence are encouraged to the same degree as are convergence and conformity.

3) be organized along holistic and linear dimensions, so that breadth and depth of study are seen as complementary goals. The linear, left-hemispheric, reductionistic dimension allows for in-depth exploration of concepts in an atomistic fashion from simple to complex. The holistic, right-hemispheric approach encourages connectedness among principles, and the topics are so organized as to provide an advance organizer for the student. Andersen (1978) illustrates this attitude in the POEM model, where a science concept is studied along its philosophical, empirical, futuristic, technological, historical, and social dimensions.

4) reflect the knowledge that the processes of scientific inquiry are as essential to understand as are its products, that the acts of generating new ideas are as valuable as are the methods used to test their correspondence with reality, and that the scientific enterprise is both subjective and objective, resting on the human values of honesty, cooperation, and responsibility.

There are several curricular programs available which enable instructors to introduce these qualities. Among these are:

1) The Human Sciences Program (HSP, 1980) The primary goal of this program is to relate curriculum materials to the characteristics of adolescents. It emphasizes interdisciplinary teaching, is developmentally based, modular activity-centered, personalized, and flexible.

2) Outdoor Biology Instructional Strategies (OBIS, 1976) The principal focus of this program is on contemporary environmental issues of significance for adolescents. The activities are field based, interdisciplinary, personalized, and flexible. Community group leaders, as well as teachers, can utilize the materials in large groups, small groups, and in situations which call for individualization.

3) Elementary Science Study (ESS, 1966) These units, produced by teachers and content specialists, are activity centered, flexible, and open-ended. They are based on the premise that adolescents are scientists by disposition--they naturally question and explore their environment. The activities provide an opportunity to reinforce science concepts and processes for middle school students.

These programs offer far more for students than do the traditional group-paced programs which have all students using the same text to meet the same expectations by completing the same activities at the same time.

There is an additional factor which is becoming increasingly important in preparing teachers and developing curricula for students. The assumption is often made that all teachers have the ability to function at both concrete and formal operational thinking/reasoning levels. This is not the case. Many teachers and prospective teachers are in the transitional stages themselves or, simply, are not presently functioning at a formal level in the sciences. This diversity of thinking/reasoning ability must be taken into consideration in planning a program for teachers. Since middle school students are moving from concrete to abstract or formal operational thinking during adolescence, teachers must first have an understanding of the various operational thinking/ reasoning stages and, second, be able to move from concrete to formal thinking/reasoning levels as specific teaching situations arise. This also requires that teachers, especially at the middle school level, be familiar with several approaches or strategies for teaching and learning science in order to be effective in their classrooms.

MIDDLE SCHOOL SCIENCE INSTRUCTION

The preparation of undergraduate teachers must be related to subsequent graduate coursework. The undergraduate program cannot complete the entire process of developing master teachers, and the graduate in-service component must be considered in conjunction with it. As a result, our program emphasizes teaching skills in the undergraduate program and instructional strategies in the graduate program. The major effect of the two programs is to separate strategies from skills.

There are numerous teaching skills introduced in the undergraduate program. The student is given opportunities to conduct a discussion, use audio-visual aids, realize the importance of humor, improve speech and listening skills, conduct field trips, order and maintain equipment, realize the necessity for enthusiasm in teaching and learning, ask effective and appropriate questions, establish learning objectives, fill gaps in science concept background, understand nonverbal language, determine student performance levels, practice good safety habits, develop examinations, prepare student assignments, understand the difference between grading and evaluation and how to use both, help achieve institutional goals (state, local and national), diagnose student needs, conduct laboratory work, seek in-service experiences, vary teaching techniques, work cooperatively with colleagues and superiors, develop a concern for students as humans, and orchestrate all of these into a meaningful teaching/learning environment for the middle school student.

Humanism in the classroom, although placed near the end of the list above, is one of the most essential skills for a teacher to develop, especially in the middle school. Abruscato and Hassard (1976) list five reasons for emphasis on the humanistic view of science:

1) Science is a human experience. It involves humans looking out at their world.

2) Science usually involves a cooperative human effort. The scientist, alone, high in the ivory tower, is an inaccurate view of the scientific role.

3) The basic processes of science, such as discovering, valuing, and exploring, are applicable to many of the human social problems people face, problems that include social change and the improvement of interpersonal relationships.

4) Certain products of science, as transmitted through technology, can be used to alleviate human suffering resulting from poverty, disease, and illiteracy.

5) The essence of humanism, as we see it, is that each human being should be encouraged to utilize her or his full human potential, as well as intellectual and social potential. (p. 6)

In addition to the introduction of teaching skills, a select few instructional strategies are presented as a lead-in to the graduate program. Those that are selected come from the work of Joyce and Weil (1980) in which four families of strategies are identified. Within these families are 23 models of instruction. In the undergraduate program, however, only one strategy from each family is selected, based on what a beginning teacher would find most useful in middle school science teaching.

From the Information Processing Family (Joyce and Weil), the inquiry strategy is presented in both inquiry training and guided inquiry forms. These strategies include the work of Suchman (1962) and Schwab (1965). Inquiry permeates most of the middle school science texts selected for use and is also the heart of most curriculum materials of the '60s and '70s. Inquiry strategies are also quite consistent with the needs of the emerging adolescent to explore and conceptualize the world.

From the Social Family (Joyce and Weil), the cooperation/competition/individualization strategy is introduced. This strategy is most prominent in the work of Johnson and Johnson (1975), and is designed to allow the undergraduate to experience three different instructional modalities and to gain knowledge in planning middle school programs. Competition in this model is used for drill work and review, whereas individualization is used for at-home assignments and in pursuing individual interests. The rest of the instructional day would emphasize cooperation. Based on research evidence it is recommended to the undergraduate student that he/she plan about 70 percent of class time for cooperative-oriented learnings, 20 percent for individualized learnings, and 10 percent competitive learnings (Johnson and Johnson, 1975).

From the Personal Sources Family (Joyce and Weil) the nondirective strategy, based on the work of Carl Rogers (1969) and other open learning advocates, is presented. Within this approach the undergraduate realizes the positive effect of facilitative communications in science lessons on achievement. From the Behavior Modification Family (Joyce and Weil), the contingency management strategy, as illustrated by Rimm and Masters (1975), is demonstrated. The student gains an understanding of how to develop self-correcting, immediate feedback instructional systems such as learning centers.

Another major area of concern of the teacher preparation program for middle school teachers is a thorough understanding of the processes of science. These are essential to the learning of science. The processes can be treated and used in a very elementary or a sophisticated manner, depending upon the experiences of the learners. While all students may be free to explore many science areas, and while they may explore their science interests in a variety of ways, the processes must be used continuously for significant learning to take place.

In order to facilitate the understanding of these processes in an individualized manner, a set of self-paced "tubs" or modules have been developed. Each "tub" contains a series of experiences that utilizes one specific process. In addition, the activities in the modules are designed to be used directly with middle school students in both methods and student teaching experiences. Five "tubs" have been developed for each of seven processes in each of three science areas: life, physical, and earth. This would allow for a student to have as many as 15 sets of experiences in any one process, and 35 sets of experiences in any one science area such as earth science. Students can elect to complete as many as they need in order to gain the necessary competence.

Two key ingredients to the success of the undergraduate program are the effective modeling of science teaching strategies, and the incorporation of a field-based component with middle school students. These aspects are based on the rationale that if the undergraduates experience rewarding science teaching strategies as students, then they are more likely to use them with their students. Furthermore, the field-based aspect is developmental in nature, whereby a one-to-one format is utilized initially so that the college student can experience intimately the needs, interests, and communication behaviors of middle school students. In addition, the undergraduates are given experiences with small groups of middle school students in order to reinforce skills and strategies, as well as to facilitate the student-teaching experience.

CONCLUSION

As one looks at the program, it is easily observed that all of its components cannot be completely satisfied in one undergraduate course. The learner needs to experience each component many times--both in theory and in practice. Even an extensive graduate program will not provide total mastery.

Curricular materials for middle school learners are so varied that it is difficult to know what to present in the undergraduate course. A number of elementary as well as secondary programs would be appropriate. In addition, there is a vast array of supplementary materials available. A curriculum package that works for one youngster may not be effective for another. Multiple resources are essential. In our efforts, curricular materials are not stressed as much as is instruction since instruction is what most teachers spend the majority of time doing in the classroom. While it is difficult to separate curriculum from instruction, most beginning teachers are given curricular materials, whether they like them or not. Even teachers working for several years often have little impact in modifying the curriculum guide and materials they use. While this is not good, and teachers must have some control over the resources they use, our choice is to stress the instructional process for the preservice teacher. We then give extensive treatment to the curriculum in the graduate program and through in-service workshops. This structure is based on the belief that if a teacher is competent and knowledgeable in the area of instruction, he or she can manipulate any curriculum to fit student needs.

One of the finest books available for middle school teachers to experience is The Whole School Book (Samples et al., 1977). The first two sentences in Chapter I state, "The meadows of mind are unbelievably personal places. Whenever any of us are invited to share our minds, a whole universe of events comes rushing into action" (p. 1). It is this "universe of events" that we try to orchestrate and foster in teaching middle school youngsters--or all learners of all ages. The more we reward and encourage these emerging adolescents to share their "mind meadows," the better we can help them understand who they are and where they belong. And the more we share our own "mind meadows" with our students, the more they will understand us and grow from sharing in our experiences.

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IMPROVING PRACTICES IN MIDDLE SCHOOL SCIENCE TEACHER PREPARATION: THE GEORGIA PLAN

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INTRODUCTION

A growing dissatisfaction with the organization and content of the junior high school has led to a minor revolution in the education of early adolescents. While the junior high school started out with admirable aims of providing appropriate experiences for students in grades 7-9, many educators, community leaders and, especially, junior high school students over the last 20 years have become increasingly aware of the institution's shortcomings. This dissatisfaction has led to the upsurgence of the middle school. In 1967, Cuff found only 500 middle schools nationwide, while Brooks (1978) identified more than 4,000 throughout the United States in 1978. The state of Georgia, too, found itself in the midst of this change from junior high school to middle school. The number of middle schools in the state increased more than twelvefold from 24 in 1968 to 302 in 1973.

With this growth, a standard operational definition of the middle school as an institution whose programs are based on the nature and needs of the pre- and early adolescent has emerged. Because of the lack of the special skills and understandings necessary to meet these needs and because of the perceived need to have middle school teachers who want to teach at that level, special teacher training programs and certification requirements came into existence in Georgia. This chapter is an effort to describe the middle school certification requirements in the state of Georgia and to describe the middle school science teacher training program at the University of Georgia.

GEORGIA CERTIFICATION REQUIREMENTS

"The primary purpose for certifying teachers and other school personnel is to assure, within reasonable limits, that children will be under the direction of a competent staff..." (Teacher Certification in Georgia, 1978). With this general purpose in mind, the state of Georgia revamped its basic program in the mid-1970s to include middle grades certification. Instead of two possible certificates, elementary (grades K-8) and secondary (grades 7-12), Georgia began to offer Early Childhood (grades K-4), Middle Grades (grades 4-8) and Secondary (grades 7-12) certificates.

Acquisition of a Middle Grades Certificate requires specialization in at least two distinct teaching fields and the completion of a state-certified four-year teacher preparation program. Forty-five quarter hours (25 in the first major and 20 in the second major teaching field) beyond the first two core years of college coursework must be completed in two of the following areas: language arts, science, mathematics, or social studies. There is also provision for including art, music, physical education, health, or career education as the second major. In addition, all applicants for first-time middle grades certificates must take a five-quarter-hour course in the "identification and education of children with special education needs," and "must have completed a five-quarter-hour course in the teaching of reading."

THE MIDDLE GRADES TEACHER EDUCATION PROGRAM AT THE UNIVERSITY OF GEORGIA

The University of Georgia Middle School Teacher Education program includes experiences which reflect certification requirements. Most potential middle grades teachers identify themselves after completing two years of coursework called the core curriculum. The core includes basic courses in humanities (20 hours), social sciences (20 hours), science and mathematics (10 hours each), physical education (5 hours), and electives (5 hours). Upon admission to the Middle School Program, the student must choose two major teaching fields and begin the professional education component of the Middle School Program.

The Professional Education Component

At the heart of the professional education component of the Middle School Program are sets of courses designated as Phases I-IV. Table I outlines the basic courses encompassed in each phase. These phases are interspersed throughout the junior and senior years. All courses in a phase are taken as a block. Many of the courses are field-based, with numerous opportunities to observe and teach in middle school classrooms.

Phase I courses are introductory, both to the nature of the middle school and the early adolescent. Students are gently eased from observing in classrooms to working with small groups of students. Phase II courses focus on planning for instruction and on the instructional process itself. Students plan and teach their own week-long units. During Phase III the focus continues

TABLE 1

AN OUTLINE OF THE PROFESSIONAL EDUCATION COMPONENT OF THE UNIVERSITY OF GEORGIA MIDDLE SCHOOL TEACHER PREPARATION PROGRAM

Phase	Course Title	Course Content	Quarter Hours
I	1. Introduction to Middle School Education*	The aims of education; the concept of the middle school; teaching strategy observation and analysis	5
	2. Teaching Reading in the Middle School*	Methods, materials, and evaluation strategies for teaching reading in the middle school	4
	3. Adolescent Psychology	Adolescent development, interests, needs, and abilities	5
II	1. Teaching in the Middle School*	Planning lessons and units; managing the classroom; identifying and implementing instructional strategies	5
	2. Utilization of Educational Media in the Middle School	Equipment use, material construction and use, and identifying appropriate media for learning tasks	5
	3. Content Area Reading in the Middle School	Teaching reading in various content areas including science; testing, study skills and classroom organization for content area reading	4
III	1. The Middle School Curriculum	Individual differences, evaluation of achievement, organizing and evaluating the curriculum, teaching the curriculum	5
	2. Introduction to Exceptional Children	Children's disabilities; gifted students; social, emotional, educational, and vocational adjustment	5
IV	1. Student Teaching*	Full-time student teaching in each of the student's chosen teaching fields.	18

*designates field-based course

to be on planning and instruction with the students preparing and teaching a two-week unit. In addition, a stronger emphasis on middle school curriculum is included. Phase IV, student teaching, begins with a formative component wherein supervisors from the two areas of specialization, the university supervisor and the sponsor teacher, gradually involve the student with increasing teaching responsibility, giving feedback and suggestions throughout. During the last three weeks, while the student teacher has full-time responsibility for teaching, a summative assessment (using a statewide assessment measure, the Teacher Performance Assessment Instrument) is scheduled and conducted by the sponsor teacher and the university supervisor (see Capie et al., 1979).

Since the state of Georgia does not certify middle school teachers for specific subject areas (even though they require two areas of specialization!), prospective teachers must be ready to teach all subjects. Thus, five-hour methods courses for the two nonspecialty areas must be taken. For example, all students who identify themselves as mathematics/language arts majors must take methods courses in social science and in science in addition to their specialty methods courses.

Science Specialization

Each specialty area (science, mathematics, language arts, and social studies) is responsible for advising its students for 30 quarter hours of work, whether that area is considered the first or second major concentration. In science, students usually take 20 hours of science courses (in addition to the 10 hours taken in the core--normally a biology sequence) and two five-hour science methods classes. One goal of science specialization is to confer as broad a science background as possible on prospective teachers so that they will feel comfortable teaching the various science topics found in the middle school curriculum. Thus, students are urged to take science courses which complement the local curricula. Since the most common local pattern is general science in sixth, life science in seventh, and earth science in eighth grade, most students take at least five credit hours in each of the subject areas of biology, geology, and physical science.

The two specialist science methods courses are field-based and taught concurrently as one 10-hour course. These courses are usually taken after Phase III but before Phase IV. In general, students and instructor meet on campus for three 2-hour periods per week. Students are expected to spend the other four hours in a middle school science classroom experience arranged by the instructor. While tasks for the school experience are relatively structured, a general expectation exists that students are to help the classroom teacher in any reasonable way during their arranged time.

The activities incorporated into the training for middle school teachers who identify science as one of their two specialty areas have been designed to meet a generic set of goals adopted by the program faculty. These goals, their rationale, and a brief description of goal-related activities follow.

<u>GOAL I</u>--Middle school teachers should demonstrate a proficiency in the basic and integrated process skills.

The general trend in middle school science curricula involves the inclusion of process skill objectives and activities. Science content courses at the university generally do not enable students to become familiar with and competent in the process skills. Therefore, it is imperative that this need be met in the teacher training program.

The primary activity associated with process skill learning revolves around 16 self-instructional modules, each focused on a single process skill (Funk <u>et al.</u>, 1979). Each module includes a list of performance objectives, activities, self-checks, a mastery test, and ideas that can be used in the classroom. The activities require simple-to-use and easy-to-acquire materials (e.g., candles, baby food jars, spring scales, and batteries and bulbs). Many of the activities are appropriate for future use with middle school students.

Although the modules are self-instructional/self-paced, the students are closely monitored as they complete the activities. Engagement in class discussions and short introductory or evaluative process skill exercises are regular parts of class meetings.

<u>GOAL II</u>--Middle school teachers should demonstrate a full repertoire of appropriate teaching strategies and behaviors.

No single teaching behavior or strategy is universally effective for all situations. This is especially true at the middle school level where the interests, needs, and abilities of the pupils exhibit maximum variation. Therefore, middle school teachers must acquire a full range of teaching behaviors and be able to exhibit them in appropriate situations.

Thus, an attempt is made to influence the teaching behavior of the middle school teachers through four types of activities. First, the students are familiarized with two teaching strategy analysis systems, the Teaching Strategy Observation Differential (TSOD) (Anderson <u>et al.</u>, 1974) and the Data Processing Observation Guide (DPOG) (Yeany and Capie, 1979).

Second, videotaped models of middle school teaching situations are viewed and the behaviors are coded by the students using the TSOD or DPOG. From these tapes, general principles for teaching specific types of lessons (lecture, demonstration, activity, process skill activity) are abstracted and discussed.

Third, the students engage in peer teaching; they are videotaped and then required to analyze and code their own teaching behaviors. Research on these procedures indicates that the teaching behaviors are influenced in the direction of acquiring a broader set of more indirect behaviors. Finally, students teach several public school lessons; at least one is videotaped and critiqued by a university instructor.

<u>GOAL III</u>--Middle school teachers should understand and be able to respond to the needs of adolescents in terms of their social, emotional, physical, and cognitive development.

The middle school learner is unique and perplexing in that he is undergoing rapid change in his social, emotional, physical, and cognitive development. These changes cannot be ignored since they closely interact with the learning process. Thus, middle school science teachers must be able to respond to the changing individual both in a personal way and through the curriculum experiences presented.

Early activities designed to meet this goal center around the observation of pupils in the public schools. Students observe middle school pupils throughout the program; the emphasis is now directed to science classes where they continue to work with individuals, including problem students, as well as with entire classes. During the university experience social, emotional, physical, and especially cognitive development are reviewed but now with a special emphasis toward the interaction with science learning and instruction. Two major goals are stressed: (1) matching the learning method to the developmental characteristics and, (2) using process skill activities to promote cognitive growth.

<u>GOAL IV</u>--Middle school teachers should demonstrate knowledge of the range of science curriculum materials and activities appropriate for different pupils and grade levels of middle schools.

Much time, effort, and money have been expended recently on efforts to develop science curricula at both the local and national level. Some of these materials are quite effective and are designed to meet special needs of the middle school learner. Middle school teachers need to be made aware of the nature and extent of these materials in order that they can more intelligently select and/or develop the best science curriculum for their situation.

The major emphasis in this area is examination and comparison of middle school curriculum materials (e.g., Intermediate Science Curriculum Study, 1970; BSCS Human Sciences, 1979) and familiarization with activity units which can be used to supplement traditional textbooks programs (e.g., Examining Your Environment, 1976 and Elementary Science Study, 1966). The students are directed also toward journals as sources of activities and teaching ideas (i.e., Science and Children, The Science Teacher, and The Georgia Science Teacher). During each of these curriculum activities, representative activities are selected and presented as students participate much as a middle school pupil would.

GOAL V--Middle school teachers should demonstrate an ability to manage both the materials and pupils in such a way as to maximize learning.

The skills most often cited as lacking in middle school teachers are the ability to manage time and materials and to control pupil behavior. It is only logical to assume that these are prerequisites to effective instruction, especially when student activity is given high instructional priority. Thus, every effort should be made to assist teachers in acquiring the management skills needed to exert adequate control over their classes.

During the school observations, university students record the on-task behavior of middle school students and attempt to note any teacher behaviors which correlate with either high on-task or off-task pupil behaviors. University classroom discussions of both effective and ineffective management and disciplinary behavior are based on these data. Especially emphasized are appropriate methods of handing out, retrieving, and storing science equipment; and, appropriate methods of managing students during activity lessons.

A role-playing activity, during which the students engage in peer teaching where their peers have been assigned roles related to typical behavior problems, is also used. The peer student is instructed on how to project this misbehavior while instruction is occurring. The "teachers" are judged and counseled on their ability to identify and control the behavior problem.

GOAL VI--Middle school teachers should plan and prepare science instruction for achieving objectives with learners of different abilities and interests.

Careful planning and preparation is the first step toward success in any venture. Middle school teaching is no exception. Planning requires not only knowledge of content and organizational skills but also an attitude that values planning as an essential activity. The function of the training program must then be to instill both the skills and the attitude in the middle school teacher.

The planning emphasis here is a continuation of training that starts very early in the Middle School Program. Therefore, most of the basic skills in planning have been mastered. The task now is to direct these skills toward objective writing, lesson planning and unit planning for science instruction.

Writing behaviorally stated objectives, using Bloom's taxonomy, and selecting and writing appropriate science objectives are stressed. Lesson planning is reviewed. Students write several plans throughout the course for microteaching and middle school teaching sessions and for their final unit plan. Since unit planning is largely a function of creative abilities and familiarity with the many resources available to science teachers, unit development is a natural outgrowth of the review of various curriculum sources. Students submit a unit as one component of their summative evaluation. Formative feedback regarding this unit development is given to students at various times throughout the course.

<u>GOAL VII</u>--Middle school teachers should be able to construct formative and summative measures of science objectives.

An important but often neglected area of teaching is assessment and evaluation of instruction and pupils. Only through objective assessment of desired outcomes can the planning and execution of lessons be judged for effective ness. Also, it is only through systematic assessment of pupil achievement that we can diagnose learning difficulties and make decisions about the learner's acquisition of skills and concepts. Every effort should be made to impart the competencies of sound measurement techniques to the middle school teacher.

The characteristics of a good classroom test and reasons for testing are reviewed and discussed relative to science instruction. The importance of using a table of specifications to ensure the above characteristics is stressed. Different types of tests are discussed, with the concepts of formative and summative evaluation and the uses of pretests underscored.

Item construction is strongly emphasized and practiced with proper use of multiple response, short answer, and essay items examined and discussed within a science context. In addition, the construction and implementation of a laboratory practical exam suitable for middle school students is discussed. Students then construct both formative and summative measures for a unit of instruction.

<u>GOAL VIII</u>--Middle school teachers should be able to identify resources available through professional organizations and journals.

Any well-rounded professional possesses an awareness of the organizations and publications unique to the profession as well as some understanding of the purposes and services of each. Many publications and several organizations can serve as excellent resources for the middle school teachers. Thus, training activities should call attention to these sources of ideas, information, and assistance.

The activities related to this goal are interspersed with other goal-related activities. For example, when curriculum materials are being examined, the "how-to-do-it" and curriculum review sections of journals are examined. Special middle school services and information of the National Science Teachers Association are also explored.

Methods for the Non-Science Teacher

The science methods course for those students not selecting science as a major field aims at inculcating objectives similar to those emphasized in the major's courses. However, by necessity the treatment of these objectives is somewhat abbreviated. Other differences are: the course is not field-based, less microteaching is experienced, and, fewer total hours of coursework (50 hours versus 100 hours for majors) are involved. Another difference attends to a need identified in the students. Since most have a poor attitude toward science and science teaching, special emphasis is placed on relieving their anxiety and fears and on improving attitudes.

WHAT NEEDS TO BE DONE

While the present program at the University of Georgia has been successful in most ways, there still remain some problem areas where additional effort is needed. One major problem is the lack of subject matter certification within the state of Georgia. Presently there is a teacher surplus in language arts and social studies, and a shortage in science and mathematics. Because of the lack of subject matter certification, administrators can legally place any middle school certified teacher in a science classroom. Those without science as a specialty have only minimal preparation to teach science (two content courses and one methods course). Many do an inadequate job. While professional educators have long argued for subject matter certification, it seems unlikely that this will come about soon. Many small, rural school districts would be especially hard hit because of the lack of teachers in mathematics and science and because of their inability to attract those who are available. Superintendents of such districts have successfully lobbied for a more flexible middle school certification, although this probably leads to less adequately prepared science teachers.

A second problem arises from the predominant organizational structure of the middle school in Georgia. Most middle schools in the state encompass grades 6 through 8 and use a block-time organizational pattern (e.g., a mathematics science or language arts-social studies block taught by one teacher) or one where students move from one class to another as in high school. Thus, the University of Georgia Middle School Teacher Preparation Program trains preservice teachers to deal with the problems that arise in such classrooms. However, the state certification definition also allows middle school teachers to teach grades 4 and 5. These grades employ a predominantly self-contained organizational pattern because they are usually housed in elementary schools. Most of the teachers coming from the University of Georgia program are only minimally prepared to deal with the self-contained classroom. A mathematics/science student, for example, might not be well prepared to teach a curriculum dominated by language arts. While some students request that some of their field experiences during Phases I-IV be accomplished in an elementary school, others do not. In the future this will begin to cause problems, since only middle school certified teachers can legally teach grade 5 and this grade is most often included in the elementary school.

A third but minor problem is related to the advising of students in the program. Because of the nature of the program and the philosophy of shared responsibility, each student has three advisors, one for each specialty and an overall program advisor. This can cause problems since the advisors sometimes offer conflicting advice or opinions. If one believes in the need for a shared advising load, however, then the only solution is to attempt to improve advisor-student-advisor communications. One attempt at doing so has been the initiation of mass advising/preregistration meetings where students can meet all their advisors to discuss special problems or situations. These meetings have provided an excellent opportunity for both formal and informal discussions.

While the problems discussed above are a cause for some minor concern, they should not be construed as major drawbacks for the University of Georgia Middle School Science Teacher

Training Program. In fact, the evidence collected from supervisors of student teachers and principals indicates that the program prepares excellent middle school science teachers. Above all, the program prepares individuals who _want_ to be middle school teachers and who _want_ to work with pre- and early adolescents. This is a _distinct_, positive change from the situation seen in recent years and is a much needed change.

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IMPROVING PRACTICES IN MIDDLE SCHOOL SCIENCE TEACHER PREPARATION: THE IOWA PLAN

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INTRODUCTION

Many attempts to improve science education have come and gone over the past 20 years. Many of these programs were well-planned, supported, and publicized; few, however, have had the impact that was expected. Whether financed by federal, state, or private monies; whether innovative or traditional, hardcover or soft, all seem to have met a similar fate: in the classroom little has changed but the materials.

Many science educators identified the problem immediately--the teacher. Millions of dollars then went into elementary and high school in-service teacher education efforts, also providing doubtful impact in the long run. To surmount this problem, a few curricula were designed specifically to be "teacher proof." Some of these moved the teacher into a managerial role and were moderately successful for a while, but most met the same ignominious fate as prior curriculum efforts. Those few that met with some acceptance were often stretched, pushed, pulled, and distorted to fit into the yawning vacuum of the middle school.

Gradually it became apparent that changing the curriculum did just that and nothing more; to change classroom practices and attitudes, teachers had to be reached early and involved in a major way. Preservice teacher education was at least as important as in-service education, if not more so! Along with this new awareness came new funds for developing preservice secondary science teacher education programs. Some of this money, from the National Science Foundation, was awarded to the University of Iowa Science Education Center in 1970, and the Iowa model that developed placed strong emphasis on preparation for middle school science teaching.

The Iowa-UPSTEP preservice teacher education model, as it now exists, revolves around middle school preparation and clinical experiences. This holds true regardless of the prospective teachers' ultimate goals of subject and grade level. Three semesters of middle school clinical practice provide a base of experience for the seminars which accompany them. Preservice teachers approach the teaching of science by thorough examination of how children learn, the nature of science and the goals of science teaching, and what research says about teaching practices.

THE CLINICAL EXPERIENCE

The use of clinical experiences in teacher education provides a convenient way of combining the skills and perspective of the university with the realism of the public school classroom. They provide an opportunity for teacher-interns to interact with a variety of teaching styles and models. Many conventional teacher education programs do not offer adequate experiences to which preservice teachers can relate abstract classroom theory. Undergraduates, in particular, in such an environment often consider much of their formal coursework in education to be irrelevant. Student-teaching, on the other hand, may not adequately coordinate with theory and other phases of the teacher education program.

Clinical experiences provide a means by which a variety of controlled experiences with students and teachers in the schools can be integrated within a preservice program. Research has shown that the cooperating teacher often has greater influence on the ultimate teaching behavior of the teacher-intern than does any other person or aspect of the preservice program (Matthews, 1967; Balzer et al., 1973). This is certainly not an optimum arrangement in a pluralistic world. A series of clinical experiences provides a wide range of contacts with a variety of teacher models in different classroom environments. Controlled experiences can expose teacher-interns to a systematic set of conditions and develop their theory and skills in a real world setting. A clinical experience uses modeling, feedback, and practice in a classroom to help teacher-interns gain certain competencies relevant to the teaching-learning process. Clinical experiences are a vehicle through which teacher education programs can stimulate the development of generalizable and realistic teaching behaviors (Lunetta, 1975).

Three examples of the use of clinical experiences in the Iowa-UPSTEP program are described below. These particular activities occur at a time when the teacher-interns are teaching in "self-paced" middle school classes.

Self-Instructional Module

Each teacher-intern designs, produces, and field tests a self-instructional module. This experience covers a variety of tasks in which the intern must be competent. The intern and the cooperating teacher are asked to select a remedial or enrichment topic for the module, to supplement the course being taught, and to be of value to both the teacher and the intern. Behavioral objectives, prerequisite skills, task analysis, and pre- and post-tests are developed by each intern. After the initial module is completed, it is critiqued by other teacher-interns. When modifications have been made, the module is used with middle school students and further evaluated. Module effectiveness is assessed using the pre- and post-tests and through observation and interviews with student users. Teacher-interns conclude this experience by preparing recommendations for revision of the module.

Case Studies

Each teacher-intern gets to know two students particularly well. Interns are advised to select one student who is having difficulty in the course and one student who is very proficient. Extra time is spent in assisting and talking with these students, and a case study log is maintained on these experiences. Interns are to become familiar with their students' special interests, skills, frustrations, and family orientation. They also examine student responses to certain Piaget-type tasks (introduced as part of the freshman clinical experience). A report is prepared summarizing student responses and the inferences that may be drawn from them for teaching practice. Through first-hand experience the interns discover that students in a class are at different levels of intellectual development, interest, and skill, and in seminar they examine ways to respond to these real differences in students. This experience is excellent reinforcement for human relations skills also being presented in seminar and developed in the field.

Teaching for Inquiry

Interns are introduced in seminar to the philosophy and teaching strategies underlying teaching for inquiry. They practice these strategies in microteaching sessions with their peers and subsequently with groups of students in their middle school classroom. Audio and video tapes and other forms of feedback are used to enable the interns to monitor the development of specific inquiry teaching skills.

A PERSONAL RATIONALE FOR TEACHING

Combining their own developing understanding of how children learn, the nature of science, and the goals of science and teaching into a rationale for science teaching is a central theme of the Iowa-UPSTEP program. This theme gives preservice teachers an opportunity to develop compatability and integration among the various aspects of their curriculum and teaching. Three semesters of clinical experience prior to student teaching allow them to develop and field-test their own rationale and skills. The Iowa-UPSTEP program is more than this, however.

Iowa-UPSTEP is a four-year program in which students are provided with relevant science education experiences beginning in the freshman year and continuing throughout their undergraduate years. Providing undergraduate students with early opportunities to deal with some of the realities of science teaching allows them to make equally early commitments to science education or to change their career goals.

Early entry into the science teacher preparation process also encourages long-term student-faculty relationships--relationships which seem necessary in helping students become more competent science teachers. Students who spread their professional preparation over all four years also find that science courses become a more integral part of their total program.

The ultimate goal of Iowa-UPSTEP, however, is to facilitate the development of individual teachers by expanding their initial rationale into a significant research-based rationale for teaching science and furthering their ability to apply that rationale in a classroom setting. This final rationale is essentially a conceptualization of the dynamic, simultaneous interaction of all the following:

1) teacher, student, and societal goals for science education;

2) why science should be taught;

3) what science must be learned;

4) the nature of science;

5) the nature of children and learning;

6) how to facilitate learning in science in a manner consistent with what is known about children, learning, and science;

7) how to personally assess, evaluate, and change classroom climates and strategies to achieve progress toward stated goals.

In the Iowa-UPSTEP model, such a rationale must have a research-supported base; it must be defensible in terms of current research. Statements including "I believe...," "They say..." or even "I tried it and it didn't work" are not considered to be adequate supporting evidence for a teacher's rationale.

THE IOWA-UPSTEP PROFESSIONAL SEQUENCE

To enhance development of the preservice teacher's rationale and skills, the current Iowa-UPSTEP program integrates the professional education sequence with the total undergraduate program. This professional sequence provides seminars each academic term and includes at least four different clinical experiences.

Freshman Year

In the fall, weekly seminars and occasional social events introduce incoming science students to the University and to issues in science and education. Most of these students do not plan to teach. Half of these early seminars involve scientists discussing their personal evolution as scientists as well as their views about the nature of science and science teaching. During alternate weeks the students discuss issues which are stimulated by the visiting scientists while becoming aware of communication and group process skills.

Many of these early seminars are directed toward science career awareness. Many students are poorly informed about the science career options available to them. By interacting with a variety of scientists, undergraduates can get a better feel for both the careers themselves and the preparation leading to them.

Along with the more obvious aspects of career development, students also become strongly aware of the varying abilities of different scientists when it comes to communicating science. These students have long dreamed of being good and effective communicators of science, and the important role of scientist as educator and communicator is developed in alternate weekly discussions. During these sessions students begin to analyze and dissect not just the person, the career, or the research presented, but they also critique the delivery. This close look at communication skills is facilitated by participating in a series of communication skills exercises during other seminar discussions. Combining an awareness of communication skills with enrollment in various science courses and with weekly opportunities to use these skills in a seminar setting usually leads to a desire for further enhancement of those skills. When science teaching is presented as one of many science careers, science-oriented undergraduates with some firsthand knowledge about effective communication begin to see good teaching as more and more important (Penick, 1979). Not only do many want to acquire those teaching skills, but they wish their own science instructors had them as well!

For those students desiring to find out more about science teaching, at any level from kindergarten through graduate school, a one-semester course is offered. As with the prior seminar, this is a pass/fail graded course with grades based on attendance. This makes both courses less threatening and more exploration is encouraged.

During this time students spend three hours a week in a fifth- or sixth-grade science classroom. Students also attend a weekly seminar designed to make the experience more productive for both the children involved and the UPSTEP student. Seminar activities include working with materials from activity-centered curricula, discussing field experiences, talking with classroom teachers and other professionals, discussing child development and relevant learning theory, and probing the basic question "What is science and how do I teach it?" Developing and field-testing science activities provide culminating experiences.

During these two freshman semesters students are strongly encouraged to examine their career goals. Following the first field experience, a few students may decide that pursuing a degree in elementary education is a major goal while others will select other teaching levels. Naturally, many make decisions resulting in careers only distantly related to science education.

Sophomore Year

The second UPSTEP fall term begins by introducing students to more formal issues in teaching and learning. The relative roles of elementary, middle, and high schools are examined as well as their histories, administration, and finance. School law and relevant cases from science classes and laboratories are reviewed. These discussions help provide a better historical basis for their teaching rationale.

This year also sees undergraduates beginning a two-semester sequence in the history and philosophy of science. Emphasis is again on the nature of science and communicating science. These cultural, scientific, and human issues critically merge with issues in education to help broaden the preservice teacher's perspective. An optional clinical experience in an open-space middle school allows Iowa-UPSTEP students to experience a variety of creative educational alternatives while continuing to examine personal goals and values relating to education. A course in educational psychology, with a strong emphasis on developmental and adolescent psychology, further rounds out the educational experience.

A weekly seminar series, similar to the first freshman experience, is open to all UPSTEP students each spring semester. These seminars continue to feature scientists from a variety of academic areas. Some of the speakers are science educators. These science educators tend to focus directly on communicating science by means of improved curricula, films, teaching strategies, and innovative teacher education programs. The scientists bring their own perspectives. These include the goals of undergraduate science courses, teaching for scientific literacy and preparation to become a professional scientist.

Junior Year

By the junior year, students in the Iowa-UPSTEP program have had several opportunities to make career decisions and they are deeply committed to science teaching. Capitalizing on this commitment are two successive semesters of intensive methods seminars. The first of these provides a field setting in a middle school, self-paced program. Developing and evaluating a self-instructional module, assessing levels of intellectual development in children, preparing case studies, individualizing instruction, developing human relations skills, and exploring teaching strategies appropriate to conceptual learning in science are all emphasized. During this time the Iowa-UPSTEP students are also actively involved in a self-instructional laboratory which provides models, resources, and assistance for designing and producing self-instructional materials.

Students meet the same middle school science class each day for an entire semester. Since the class is self-paced, the UPSTEP teacher-intern can work with one student at a time or with students in small groups. The UPSTEP student can experience the full role of the teacher without the problems associated with daily lesson planning. Where possible, four or more interns are assigned to one cooperating teacher to increase communication between cooperating teachers, interns, and university staff. The seminar, meeting four hours per week, provides the teacher-interns with opportunities to interact, assess, and learn more about teaching, science, middle school students, and themselves.

The second junior-year methods seminar provides opportunities to explore and interact with a variety of science curricula while further developing science teaching strategies. These teaching strategies, in combination with prior aspects of the UPSTEP program, enable students to put together, for the first time, a thorough rationale for teaching science.

This rationale, including goals for science students, the nature of science, how children learn, and teaching strategies, is followed by UPSTEP students throughout four teaching sessions in a middle school classroom. Now, for the first time, UPSTEP students deal with a total class and do all the planning. To make this transition to the whole class easier, UPSTEP students work in teams of two or three and teach only one science class for the four days. All four days are videotaped and much emphasis is placed on analysis and self evaluation of the tape. A written critique is given to the instructor and then the whole class (usually about 9-12 students) critiques the film with the interns.

Following this analysis, the teacher-interns revise their curriculum and teaching strategy and again teach the same science lesson for four days to a different group of middle school students. Once again, videotapes are made during each lesson and the self- and peer-evaluations are repeated. The middle school students themselves also provide feedback through teacher-intern designed evaluation forms. Each preservice teacher writes a complete evaluation of his or her eight-day experience. Feedback on ability to self-evaluate and the university instructor's perceptions of strengths and weaknesses is provided during a 30-minute individual interview session with the instructor. While good science teaching is important, the main goal of this activity is not to demonstrate excellence in teaching. Rather, it is hoped that UPSTEP students will improve self-evaluation skills, make decisions about curriculum revision, and become less defensive when faced with intensive personal feedback. Teachers who can critically analyze their own teaching in scientific ways are more likely to continue to grow as professional teachers, than those dependent on outside evaluation (Johnson, 1970).

Summer Program

The summer program has been a very valuable part of the Iowa-UPSTEP program. Designed to break down preservice-inservice barriers, and available after completion of the two methods courses, the program provides two major options for junior students. UPSTEP students can be found working as teacher-interns or counselors in various activities of the Iowa Secondary Science Training Program. These involve working on campus or on extended field trips to natural areas with high school students or serving as staff in the UPSTEP Summer Curriculum Revision Workshops for in-service teachers. In the latter capacity, undergraduate students help teacher participants review resources relating to their own curriculum development objectives while preparing materials, plans, and strategies to meet those objectives.

Senior Year

At this time, teacher-interns participate in advanced clinical experiences that are similar to traditional student teaching. Although Iowa-UPSTEP students assume responsibility for planning and teaching secondary science classes under the supervision of a cooperating teacher, this is not always the usual, all-day, all-semester experience. This advanced experience may continue at a reduced pace throughout two semesters and it may be paired with selected teaching experiences in classes for Iowa-UPSTEP underclassmen.

SUMMARY

Using clinical experiences in the middle school during a four-year teacher education program provides a convenient means of combining the skills, perspectives, and intimacy of the university environment with the realism and vitality of the middle school classroom. The Iowa-UPSTEP program permits a variety of entry and exit points for students who wish to explore teaching as a career alternative while facilitating attitude and behavior changes which are appropriate for effective teaching. Many of these changes are a result of working amidst the great diversity found among middle school students. At the University of Iowa, a middle school is a place to learn as well as a place to teach.

The National Science Foundation has provided funds to evaluate the total effectiveness of the Iowa-UPSTEP program and to write modular materials which can assist other institutions in organizing four-year, clinically oriented science teacher education programs. The results of the evaluation indicate the successful nature of the program and are providing impetus for further evolution of the model. Iowa-UPSTEP teacher education modules are being used at more than 30 teacher education institutions in the United States and in several foreign countries.

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CHAPTER IX

IMPROVING INSTRUCTIONAL PRACTICES THROUGH INSERVICE: THE UNIVERSITY AND INSERVICE

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INTRODUCTION

To have an impact on improved science instruction in middle schools, the roles played by university professors in in-service education need to be different from those that have historically been taken. Recent evidence should cause us to question the value of two of these traditional roles that have been played in the continuing education of science (or any other) teachers. Both the professor-planned graduate course, whether offered on or off campus, and the one-shot workshop presented to fill a time slot in an in-service day, have questionable records with regard to changing teacher behavior in the classroom. In spite of this, the role of university professors in in-service education is becoming more critical as local districts cut back on science supervisors because of budget crunches. Before developing guidelines for successful in-service programs involving university personnel, this section will deal first with what is known about successful in-service programs. Then the special problems of, and opportunities for, improving science instruction in middle schools will be addressed. Finally, a model for effective in-service programs involving universities with local districts will be presented.

CHARACTERISTICS OF SUCCESSFUL IN-SERVICE PROGRAMS

The setting, method of planning, and procedures for implementation have a bearing on the outcome of in-service programs. Lawrence et al. (1974) have provided an extensive review of literature dealing with the successes and failures of in-service programs in reaching their objectives. Although university-based in-service programs (courses and institutes) can have an effect, particularly on teacher knowledge of content and methods, school-based programs are able to influence more complex behavioral changes as well as to influence teacher attitudes. For changing teacher performance (not just knowledge levels) the local school provides a better setting than the university. Mini-courses, as opposed to workshops, institutes, etc., aimed at developing specific skills have a high rate of success. Those aimed at affecting beliefs, values, concepts, and information levels are not so successful.

In the planning of school-based in-service programs, local participation is associated with higher success rates than is outside planning. When teachers help plan the activities there are higher success rates than when university people plan alone. Likewise, school-based programs planned by supervisors and administrators tend to be more successful than those planned by university personnel alone. However, the highest success rates occurred for those programs jointly planned by local supervisors and outside consultants. In addition to the finding that who does the planning makes a difference, how the planning is done also influences the outcome. Programs that are entirely pre-planned are not as likely to result in success as those in which the design of the program emerges from the initial interaction of teachers and presenters. In addition, those programs that are initiated by teachers have been found to have a much higher success rate than those programs initiated by others.

As far as the implementation of the in-service program is concerned, five factors have emerged to distinguish successful in-service activities from those that are less successful. Successful programs are those that are individualized to meet the needs of different participants rather than those that consist of common activities for all. The most successful programs also tend to involve self-instruction, self-instruction based not on aimless wandering but on the use of prepared materials, planned guidance from an instructor, and/or a set of agreed upon objectives or expectations. Higher success rates are reported for programs that put teachers in an active role--generating ideas, materials, or behavior--rather than in a receptive role. If the in-service program gets teachers involved in trial performances and feedback, it will tend to have more success than a program that requires teachers to store up prescriptions for future behavior change. The fourth factor that distinguishes more successful programs is allowing teachers to share their work as opposed to working separately. A final factor that Lawrence *et al.* found to be related to higher success rates is the in-service work being related to the programmatic efforts of the local school. Lower success rates were found for single-shot presentations not related to program development.

Several recent reports of middle school in-service efforts have substantiated the findings of Lawrence *et al.* (1974). Klingele (1977) reported success in several areas for a program jointly planned by local school authorities and university people. Taking into account participants' varying roles, learning styles, and competency needs, this program also involved individualization of instruction. Tyrrell and Natko (1977) described a program that actively involved teachers in applying a problem-solving approach for solving classroom problems. The program not only improved teacher behavior but also how they felt about themselves and their jobs. Bourgeois (1978) related several successful in-service efforts which included joint planning and teacher sharing. Anderson and Snyder (1979) described a comprehensive programmatic in-service program that was based on conceiving the middle school as an ecosystem. In-service education was not focused on disseminating a few tricks of the trade but involved the concepts of learning, planning, and leadership that used creative problem-solving in an organizational setting. McDaniel (1979) emphasized active group learning in a successful in-service program he planned with a local school district. Bunker (1979) put several of these above mentioned principles into operation in an in-service program aimed at establishing a new junior high in Washington, D.C. These principles included the following: learning is an active process, shared decision-making increases learner involvement, success breeds success, and group process is important in learning. Lawrence and DeNovellis (1979) have further validated the success of an approach to in-service education that revolves around self-managed skill development with the support of a peer panel. Greer (1979) reported on four successful programs that have in common active teacher participation, follow-up, and a relationship to program development.

For university people to successfully change teachers' classroom behaviors and attitudes, they must be engaged in a dialogue with local school people in both the planning and implementing of in-service education. The university personnel must respond to teachers' different learning styles, interests, and perceptions of need. Without providing for active teacher involvement in in-service planning, the university person might as well stay home!

SCIENCE INSTRUCTION IN A MIDDLE SCHOOL

The focus of this section concerns some widely held views about the proper organization and functioning of middle schools. The role of the disciplines, science specifically, will be discussed as it relates to this broader school context. For the professor familiar with consulting in high schools, aiding in middle school staff development presents a different set of challenges. Most high schools are subject-centered institutions where each subject area is taught autonomously without regard to what is being taught in other areas. Little communication concerning instruction occurs across subject areas in these departmentalized high schools. Except in those high schools with an effective counseling program, the students' developmental needs are largely left to chance, as the requirements of subject matter development are attended to. As a consequence, to teach effectively in a high school science curriculum, one needs to be concerned primarily with the systematic development of biology, chemistry, or physics subject matter without being concerned with other areas of the curriculum. Therefore, to help a secondary science teacher via in-service education one needs to be primarily concerned with that teacher's own subject matter competence and with the teacher needs related to teaching science as a separate, albeit perhaps sequential, subject.

However, the role of science instruction in a middle school is different from that in high schools because middle schools have different purposes. The National Middle School Association (NMSA) has adopted five goals as central for middle schools. As reported by Alexander (1978), the Chairman of the NMSA Committee on Future Goals and Directions, these goals are:

> 1) Every student should be well known as a person by at least one adult in the school who accepts responsibility for his/her guidance.
>
> 2) Every student should be helped to achieve optimum mastery of the skills of continued learning together with a commitment to their use and improvement.
>
> 3) Every student should have ample experiences designed to develop decision-making and problem-solving skills.
>
> 4) Every student should acquire a functional body of fundamental knowledge.
>
> 5) Every student should have opportunities to explore and develop interests in aesthetic, leisure, career, and other aspects of life. (p. 20)

In a middle school, concern for the total development (i.e., physical, mental, and socio-emotional) of the students supersedes the development of subject matter <u>per se</u>. Lounsbury and Vars (1978) have devised a set of four curriculum guidelines which distinguish a middle school from a high school (the junior or senior variety):

> 1) Every student should have access to at least one adult who knows and cares for him/her personally, and who is responsible for helping him/her to deal with the problems of growing up.
>
> 2) Every student should have the opportunity to deal directly with the problems, both personal and social, that surround him/her (e.g., ethnic diversity, human development, ecology, relations among nations, economic issues, etc.).

3) Every student should have the opportunity to progress at his/her own rate through a continuous, nongraded sequence of learning experiences in those areas of the curriculum that have a genuine sequential organization.

4) Every student should have access to a rich variety of exploratory experiences, both required and elective. (p. 41)

These curricular guidelines do not include the formal study of disciplines. On the contrary, science taught well in a middle school serves goals and objectives related to meeting the developmental needs of early adolescents. Consequently, one does not approach science study in middle schools by asking "What do I need to do in order to systematically develop the discipline of biology (or chemistry or physics) to prepare building young scholars to pursue further science study?" The teacher and university consultant need to ask "What developmental needs of early adolescents can be met by an understanding of some science concepts or by developing skills associated with scientific inquiry?"

The planned interaction between students and teachers in middle schools is more complex than that in high schools. In the first place, the middle school teacher needs to be as concerned about his/her role as a nurturing, caring adult as about his/her role as an "expert" in science. Science content and science skill development serve both roles. In fact, the emphasis of science instruction is on how science can help an early adolescent understand himself/herself and his/her widening environment, not on how to produce a child with a wealth of formal science information. This latter role is properly left to the high school and college.

In addition, since early adolescents are notorious for having many interests, many of which are short-lived, it is important to be able to offer short courses (mini-courses, modules, exploratories--call them what you will) in specific areas of science. A series of two-to-four-week exploratories on high-interest topics ranging from black holes to human anatomy need to be made available in a middle school setting. These topics are often selected, <u>not</u> by consulting a curriculum guide, but by consulting students <u>and</u> taking into account their current interests.

Science instruction in a good middle school will not be limited to offering exploratories, but will also be part of the core curriculum. But even here science will not often be taught as a discipline in isolation. Since student questions about the world around them seldom fit into neat disciplinary categories, science is increasingly being taught in the context of an interdisciplinary team, including language arts, social studies, and mathematics teachers. Though the number of teachers on a team and the specific combination of subjects represented on the team varies from middle school to middle school, the existence of interdisciplinary teams is becoming quite common. Therefore, an organizing question for a middle school science teacher often is now, "How do I best teach biology as a coherent discipline?" but, "How can biology concepts and processes of inquiry be integrated with social studies and language arts skills and content to assist in solving an intellectual problem that is interdisciplinary in scope?"

The university-based consultant needs to be concerned not only with the role of science in a total middle school program, but also with the perspectives of teachers about their own roles in the teaching of science in middle schools. Complicating the work of a university person in staff development is the probability that middle school teachers were trained as secondary science teachers and have spent time teaching in junior high schools. When the district converted to middle schools the teachers were not clear about their new roles in a different type of school organization. Consequently, to be effective in middle schools, teachers need as much in-service training concerning the new organizational pattern and the new roles expected of them as they do in the teaching of science <u>per se</u>. The total in-service effort needs to include more than a subject-centered focus.

Also connected to the teachers' need to adjust to a new type of school are the feelings and emotions which accompany the conversion from junior high school to middle school. Many teachers who wind up in middle schools are frustrated high school teachers who really want to teach science as a discrete discipline. They don't feel comfortable re-examining how science should be taught to early adolescent students. Others may be willing to make the effort to change because they are aware of the inadequacies of the junior high organization to address the needs of early adolescents, but they are uncertain how to proceed and need emotional support as much as cognitive retraining to succeed. They need help in asking the right questions about organizing the science curriculum. Consequently, outside consultants who are working in middle schools need to be as concerned about teachers' attitudes and feelings as they are about their knowledge and skill levels.

The middle school model which includes interdisciplinary team teaching and exploratory classes provides an organizational structure which can help teachers overcome two of the biggest problems that they themselves have identified with science instruction. Stake and Easley (1978) discuss the teacher concerns of motivating students and teaching heterogeneous classes. These problems manifest themselves when teachers attempt to present traditionally organized courses. The diversity among students in interest, talent, and previous experience with science is so great, and the perceived pressures to focus on basics so intense, that teachers feel frustrated as they attempt to teach structured full-length science courses.

The exploratory approach to a portion of the daily schedule provides both teacher and students with more flexibility to meet their mutual needs. Exploratories can be offered at various levels of sophistication. Some can be theoretical and abstract for the 5 to 10 percent of 12- to 14-year-olds who are formal thinkers (Epstein, 1979). Other exploratories can be designed to promote the cognitive development of the 12 to 15 percent of early adolescents who are in the transition from concrete operations to formal operations. However, most exploratories would provide for concrete experiences that would help the 70 to 80 percent of students who are concrete thinkers develop scientific concepts and inquiry skills. Lasting only two to four weeks, exploratories would allow students to choose new activities often enough to avoid becoming bored as they can so easily do with a full-length course. Every few weeks students would make selections from among the 15 to 20 exploratories being offered. The very fact that the students have been allowed to exercise choice in selecting the exploratory increases their commitment to that exploratory. They are studying black holes, pond life, the effects of heat, bird life, body chemistry, or whatever else might be selected, not just because the teacher has said they must, but because they had a hand in choosing the topic. The element of choice plus the fact that the exploratory focuses on a single topic of high interest for a relatively short period of time is not only more motivating but also allows for the grouping of students into ability and interest groups. Yet the stigma of rigid ability groups is avoided. The "college preppies" are not isolated from the "dummies" and permanently assigned to separate science courses.

Few would argue that exploratories alone are adequate to introduce students to the elements of science that they need in order to enrich their lives. However, the inclusion of science on an interdisciplinary team allows for a more systematic exposure to science without requiring the rigid course structure found in conventional junior and senior high school settings. One way that the team setting can help with motivation and heteogeneity of ability and interest is through the use of interdisciplinary thematic units. Organized around fundamental themes that integrate various disciplines in the investigation of some significant problem, themes can emanate from science, or social studies, or literature and call for concepts and skills from all three areas. When students are studying unifying themes that they perceive as relevant to their lives, they are not as likely to become bored with the subject content and are more likely to see connections between the basic skills they are being asked to master and real-world problems. Thematic units lend themselves to solving the heterogeneity problem as well as the motivation problem. A variety of grouping techniques is possible in a thematic unit. As Sharan (1980) has documented, both peer tutoring and group investigation have been shown to promote both cognitive and affective growth. By using grouping, the high ability students can be put together to investigate a more sophisticated aspect of a theme. Other groups can engage in less ambitious group projects. However, the entire class can benefit from group sharing. On other occasions groups might be organized around interests rather than ability as the teacher attempts to accomplish different objectives. Though much of the literature on thematic units focuses on language arts and social studies (Bushman and Jones, 1975, 1979; Moffett and Wagner, 1976; Spann and Culp, 1975; Erb, 1979; and Fey, 1973) describe thematic units that integrate science, math, language arts, and social studies. Both also make use of group investigation techniques in implementing the thematic units.

In summary, what do science teachers need to know in order to teach science in a middle school setting? Teachers need to...

1) Know how to organize and deliver science material in an exploratory format.

2) Work with teachers of other subject areas to plan and deliver interdisciplinary units.

3) Know what contribution science information, concepts, and skills can make to a student's study of interdisciplinary units.

4) Know how to group and regroup students by ability and interest in delivering science instruction.

5) Be well versed in the various aspects of early adolescent development.

6) Ask the questions that will help to adapt science material to meet the needs of early adolescents (as opposed to becoming frustrated because the students don't meet the demands of the science course).

DELIVERY SYSTEM

For university personnel to have a significant effect on the performance of teachers already in service, they must work closely with public school people, both administrators and teachers. The most effective in-service relationship is an ongoing one where university personnel work with school districts over a period of time to plan and deliver in-service components which are related to a district's long-range staff and curriculum development plans. A dialogue needs to take place between public school people and university personnel. Only by mutual exchanges over time can the experience of the university professor be brought to bear the help local school personnel define and solve the staff development problems which are theirs. A request by administrators to come in and give a preplanned, one-day workshop on some aspect of science instruction is at high risk of failure. The needs of the teachers filtered through the administrators to university people who don't know the specific backgrounds of the teachers are not very likely to be met.

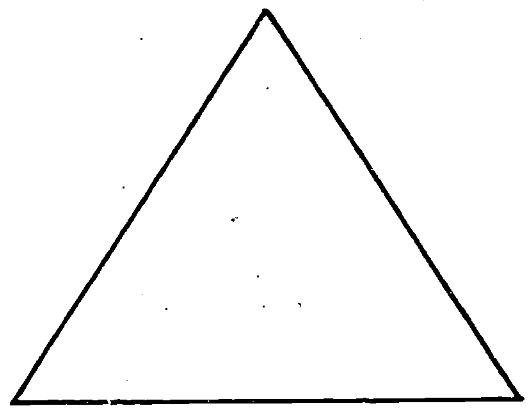
Figure 1 displays a triangular partnership that has been shown to be effective in changing teacher behavior (Erb and Manning, 1979; Erb et al., 1979). Each vertex of the triangle represents a group which must jointly plan and evaluate in-service activities. The problems to be solved are owned by the school people involved. Teachers own one set of problems related to meeting their own affective and cognitive needs. Administrators own a second set of problems related to overall program development in a school district. The university person's role is to help the school people define their own goals and objectives with regard to staff and curriculum development, and then help them achieve those goals through some type of in-service intervention.

For their part the university personnel need to play four roles in the process of in-service education. The most important role initially is to help local administrators and teachers define what it is they need. Too often their initial request for some sort of presentation is not what they really need to effect changes. The dialogue opens when the school officials initiate a request. But only after critical questioning and the gathering of much background information concerning program goals, current practices, and teacher perception of need, etc., can the university person help to define the in-service need.

That job cannot be completed until after face-to-face contact between university instructors and science teachers occurs to extend the ongoing dialogue. In addition to helping local personnel define the problem to be solved, university personnel are in a position to bring resources to bear on the defined problem. Once the problem (i.e., needs of a specific set of teachers in a specific school setting) has been identified, the university person can then adapt to local needs his/her knowledge and access to material resources. Being a person from outside the district who is not responsible for hiring, firing, or other administering, the university person is in a good position to not only meet teacher needs related to knowledge and skill in teaching science, but also to meet teacher needs in the affective area. Teacher doubts and concerns are often more readily aired in a nonthreatening in-service setting than they are in a staff meeting. By getting the doubts, attitudes, and opinions on the table they can be dealt with as an important

ROLES
1. Helps Clarify Needs
2. Brings Resources to Bear
3. Provides Feedback
4. Helps Focus on the "North Star"

UNIVERSITY PERSONNEL



TEACHERS

ADMINISTRATORS

NEEDS
1. Affective
   a. To Be Appreciated
   b. To Feel Competent
   c. To Alleviate Fears
   d. To Realize Hopes
   e. To Express Concerns
2. Cognitive/Skill
   a. To Develop Talent
   b. To Gain Knowledge
   c. To Develop Skill
   d. To Change Attitudes

REPRESENT SCHOOL NEEDS
1. Conceptualize an Improvement
2. Plan for an Improvement
   a. Set Objectives
   b. Assess Needs
   c. Gather & Organize Resources
3. Implement Improvement
4. Evaluate Improvement
5. Revise an Improvement
   a. Concept
   b. Plan

Figure 1: Triangular In-service Model.

part of the in-service activities. Outside personnel can also be more candid in offering feedback to teachers on their skill development. Listening, observing, and providing feedback in some ongoing manner is an important role for the outside in-service persons. One final important role for the university person is to function as a navigator watching the North Star. Teachers and administrators, needing to deal with the day-to-day problems of facing a building full of early adolescents, can easily lose sight of the big purposes, the ultimate objectives of schooling in general, or of teaching science in particular. The university person can provide perspective and help all concerned keep focused on the ends being sought and the relationship of means to ends.

The teachers involved in the in-service effort are complex human beings who are as much emotional as rational; their affective needs are as important as, if not more than, cognitive ones. The failure of many in-service efforts rests often on the failure to heed this fact. To be effective science instructors, teachers need to develop their own talents, gain new knowledge, develop skills, and perhaps even change some attitudes. However, there is much more to bringing about change in classroom performance than just meeting these needs. Teachers must not only acquire new skills and knowledge, they must <u>feel</u> competent, must <u>feel</u> appreciated. Teachers have defined motivation in students as a major problem in the teaching of science. So, too, the motivation of teachers is not to be overlooked. It must be remembered also that teachers approach new teaching techniques with the mixed emotions of hope and fear. Hope that they will be more effective and their students more motivated, but fear that they may not be able to pull off the new approach or that they might not even think that the suggested approach will work at all. The hopes must be appealed to and the fears alleviated just as surely as the details of new techniques disseminated. Not to be overlooked as in-service resources are the participants themselves. The dialogue must continue throughout the delivery of in-service programs.

For their part, the administrators are in charge of program development for the district. They oversee what can be thought of as a five-part spiral leading to program improvement (see Figure 2). At each step both teachers and university personnel can offer valuable input. Step one is to conceptualize an improvement. The second step is the planning for an improvement which includes setting objectives, assessing needs, and gathering and organizing resources. This stage often calls for active in-service components. The third stage is implementation of the improvement. Here is where the university personnel can provide valuable follow-through on their initial work. They can provide observation and feedback during the implementation phase. Next, the improvement is evaluated, providing a further opportunity for university follow-through. Finally, the fifth stage dovetails into the first stage of a new round of program improvement. Stage five is the revising of the concept and/or the plan so that it can be tried again. At each of the five stages university people can provide valuable help to public school administrators.

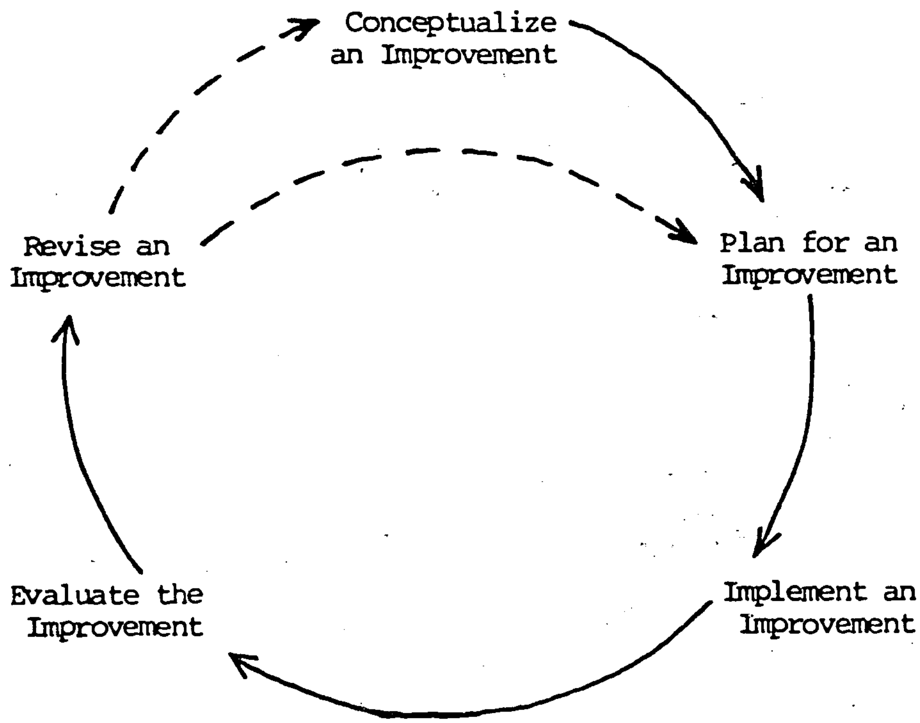


Figure 2. Program Improvement Spiral.

The objection can easily be raised that although this sounds ideal, it is too time-consuming and unrewarding in terms of what the university expects of its people. In the first place it is not suggested that this type of in-service program can be carried on by individual entrepreneurs as the current one-shot workshop system is. School districts and schools of education need to enter long-term contractual arrangements that will provide school districts with resources on a continuing basis to help solve curricular and instructional problems. Universities for their part would have access to schools for carrying out research related to the solving of real school problems and for providing better supervised field experiences. Many of these ideas were explored recently at a conference of school, university, and government representatives held in Illinois (Schneider, 1979). Precedent already exists for effective long-range cooperation between public schools and universities. Teacher education centers as established in Florida provide real, ongoing models for others to adapt (Zenke, 1976; Erb, 1978).

The ongoing relationship between university people and local school people can be summarized as a six-step process:

1) School people sense a need for staff development related to program improvement.

2) University personnel help the school people clearly define the goals, current status, and need for in-service education.

3) University consultants, continuing the dialogue with school people, organize and deliver some in-service component in which teachers play an active role.

4) Follow-up takes place in which teachers, in their classroom settings, get feedback from supervisors and university people on the implementation of change.

5) In-service program evaluation occurs in which both the local district needs are met as well as the university's research needs.

6) From the evaluation, new needs are identified, and the process continues in a new cycle of in-service programs.

The most effective in-service program is not that focused primarily on individual improvement where teachers take courses or workshops for personal interest or salary increments. These efforts do not often result in improved instruction in the classroom. The most effective in-service education comes when university people plan together with both teachers and administrators to deliver staff development components related to program improvement taking place in a local district. Success can be measured not only by assessing the implementation of new programs taught as they were intended, but also by assessing teacher job satisfaction and their own improved sense of competence and feelings of being appreciated. Affective, cognitive, and skill outcomes all need to be evaluated. Each plays an important part in effective staff development.

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IMPROVING MIDDLE SCHOOL SCIENCE THROUGH IN-SERVICE: IN-SERVICING METROPOLITAN DISTRICTS

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INTRODUCTION

Science educators are well aware of the stimulus provided by Sputnik to the teaching of science. With the continued erosion of science instruction in the United States and a "mobilization" program to better prepare all Soviet youth for a science-oriented society, it has been suggested that a climate for the improvement of science education exists in the United States today that rivals that present at the time of Sputnik (Walsh and Walsh, 1980).

While an argument can be made that an adequate number and variety of science programs for the middle grades presently exist, the problem of successful implementation remains an ongoing dilemma. The Rand Corporation report on federally supported programs for educational change suggested that, if schools are to successfully implement these programs, there must be an increased emphasis on staff development (Berman and McLaughlin, 1978). In their study, those programs that were successful in schools emphasized extended in-service education. Rubin (1978) stated that of all the efforts to influence the teaching-learning environment in schools, a basic conclusion has emerged: any attempt to improve children's learning depends on some form of teacher growth.

However, after reviewing the literature, Wood and Thompson (1980) described in-service staff development as less than adequate. In-service education has been called "the slum of American education" (Wagstoff and McCullough, 1973). Wood and Thompson (1980) suggested that most staff development programs are far removed from classroom practice, ineffective, and generally a waste of the little money devoted to them. Studies consistently suggest that the majority of educators are not satisfied with current staff development programs (Arnsworth, 1976; Brimm and Tollett, 1974; Joyce and Peck, 1977; Zigarmi et. al., 1977). This attitude exists even though there is approximately one staff member directly or indirectly involved with in-service training for every eight classroom teachers (Joyce et. al., 1977).

The above observations attempt to suggest that there appear to be serious problems in the implementation of current in-service programs. The following is a discussion of some of the many reasons for the current problems in the in-service education of science teachers. While middle school science teachers in an urban setting share many problems similar to those experienced by their colleagues in other settings, as well as by their elementary and high school counterparts, they do possess unique problems that affect their professional development. Some of these problems will provide the basis for the remainder of this section.

TEACHER PROBLEMS

Deficiencies in Preservice Preparation

Because of low enrollments in science education, state certification requirements, and lack of expertise and leadership on the university and state levels, there are few teacher education programs containing specific courses or experiences related to the preparation of middle school science teachers. Generally, preservice teachers select either an elementary (K-6) or secondary (7-12) program. State certification requirements usually do not require that elementary teachers obtain either the depth or breadth of science preparation necessary to adequately implement current middle school science programs. The preparation of secondary school science teachers usually includes in-depth preparation in one science discipline (e.g., biology) but often minimal preparation in related fields (e.g., physics, chemistry, earth sciences). Most preservice secondary science teachers view themselves as future biology teachers, chemistry teachers, or physics teachers--not as eighth-grade general science teachers (Mechling, 1975).

Reality in many districts, however, dictates that new teachers often accept middle school positions because of vacancies at that level. In some states either elementary or secondary certification may qualify teachers for middle school positions. In a survey of middle school science teachers in South Carolina, White (1979) found that 55 percent of the sample currently held an elementary teacher certificate, while 40 percent held a secondary science certificate. Five percent held a secondary certificate but not in science. The data suggested teacher deficiencies in subject matter preparation as well as in the methods of teaching science.

As a result, many current middle school science teachers have had little, if any, preparation in the physical sciences and earth sciences--courses typically included in the middle school curriculum. These teachers often are frustrated high school or elementary school teachers who, because of seniority policies, must wait their turn to move to their desired level. In too many cases teachers certified in mathematics, physical education, music, etc., are placed in middle school science positions, depending on the needs of the district at that point in time. Lack of in-service experiences designed to meet the individualized needs of these teachers reinforces their feelings of inadequacy and frustration.

Lack of Interest/Commitment to Science Teaching

Because of the above patterns and the problems often encountered related to the district wide selection and implementation of the science program described in the following sections, middle school science teachers frequently lack enthusiasm and commitment to science teaching. This attitude is reflected in many ways: (a) failure to improve themselves through active participation in in-service programs, workshops, coursework, etc.; (b) failure to participate in local, state, and national science teacher organizations; and, (c) failure to devote time to various classroom activities such as individualizing instruction, developing and modifying laboratory activities, and identifying and developing supplementary resource materials for use in the classroom and the library.

Causes of such behavior are difficult to identify. In urban settings there is perhaps a greater probability that teachers will not receive the placement that matches their perceived interests and capabilities. Also, the larger number of science teachers to be trained (and the higher ratio of teachers to science specialists) generally results in a more passive district wide focus for in-service programs. The greater degree of teacher autonomy found in urban school districts has possibly created in some teachers the attitude that any effort for classroom or personal improvement beyond the minimum expected by the district should be tangibly rewarded.

Minimum performance can also be tolerated in a school by the failure of the principal to exert pressure on teachers to continually improve themselves in areas of teaching responsibility. Increased teacher autonomy in a particular building or district can further discourage a principal from exerting such pressure.

SCHOOL DISTRICT PROBLEMS

Lack of Supervisory Personnel

In response to congressional criticism of its precollege program, three studies were funded by the National Science Foundation in 1976 (DeRose et al., 1979). One conclusion from these studies was the following:

> the absence of curricular and supervisory direction is subject to local attention and correction by local schools' initiatives. The development of an effective science program requires constant attention, leadership, and support; it cannot be left to develop by chance through the unorganized and undirected efforts of individual teachers, regardless of how excellent these individual efforts may be. (p. 35)

An hypothesis can be advanced that one of the most important factors affecting the teaching-learning environment is the lack of the expertise within the school district needed to help science teachers with the many problems associated with science teaching. Blackwood (1965) surveyed teaching practices in elementary schools and found that the lack of consultant services was indicated by teachers as a most important barrier to good science teaching. Steiner et al., (1974) reported similar findings following a survey of science teaching practices. He found that the best predictor of the teacher's role in all regions of the nation was whether there was consultant or supervisory help for teaching science within the school system. At the secondary level, Welch (1977) conducted a needs assessment using teachers and principals to identify priority goals for science education. The highest rated need was in the area of support personnel, which included such things as availability of science consultants.

While teachers appear to strongly desire the presence and aid of a science specialist in their district, only one in five of the districts surveyed in the Weiss study employed full-time science supervisors/coordinators and 63 percent of all school districts, especially small districts and those in rural areas, have no persons responsible for district-wide supervision in science (Weiss, 1978).

A recent trend has been to use "generalists" in supervisory positions. In a position paper developed by the New York State Science Supervisors Association ("Science As Basic Education," 1979), a strong defense was made for the use of subject matter specialists in lieu of so-called "generalists." In a National Science Teachers Association position statement ("On the Use of Science Specialists," 1978), employment of one or more science specialists (supervisor, coordinator, consultant) was recommended to accomplish the goals of a district's science program.

The diverse roles and functions of the science supervisor have been identified (Brewer, 1967; Del Seni, 1976; Hendrix, 1976; Neville, 1966; "On the Use of Science Specialists," 1978). The role of the science supervisor in a large urban school district is often different from that described by Ploutz (1966) and Ritz (1976) who found that science supervisors generally spend the greatest amount of their time (in descending order) assisting teachers in the classroom, providing materials and supplies, performing curriculum activities, evaluating teachers, providing in-service education, and administering government-funded projects. With one supervisor and few support personnel, there is little opportunity for interaction with teachers because of the large number of schools within the district and the many responsibilities of the supervisor. Therefore, the science supervisor in an urban setting often becomes an administrator who moves from meeting to meeting. The help individual middle school science teachers can receive with daily concerns, text selection concerns, and communication of sources of professional growth (e.g., workshops, conventions) in the urban environment is, therefore, often minimal.

The importance of the building principal as a curriculum leader has long been of interest to those interested in staff development. In the absence of a science supervisor, the principal often assumes the leadership role. Smith (1978) suggested that principals "have considerable impact on the operation of schools, both through calculated actions and through deliberate failure to act. Much depends upon teachers' perceptions of a principal's educational philosophy and on the extent to which they trust executive judgment, feel supported, and are thus inclined to aid and abet the cause" (p. 247). Weiss (1978) found that while 90 percent or more of elementary school principals felt "adequately qualified" or "very well qualified" to supervise instruction in reading, mathematics, and social studies, almost 20 percent felt "not well qualified" for science instruction. There is some reason to suspect a similar response from middle school principals. If so, their science teachers are, for the most part, on their own.

Inadequate In-service Experiences

While the studies identified above demonstrate that educators are generally negative about current staff development efforts, nearly all teachers view in-service education as necessary to enhance program objectives and their own personal development. The most common problems cited are poor planning and organization, lack of participant involvement in planning and implementation, and activities that are impersonal and unrelated to the daily problems of individual teachers (Wood and Thompson, 1980). These problems are often accented by the lack of a science supervisor within the district.

A closely related issue is the focus of in-service programs within a school district. Wood and Thompson (1980) suggested that the "largest unit of successful change in education is the individual school, not the district." Yet, as Rubin (1978) stated, most in-service programs are organized on a district-wide basis, often far removed from the needs of teachers in their own schools. The conflict between district-wide goals and training plans, based upon individual needs, is particularly felt by middle school science teachers because of the varied nature of their backgrounds and teaching responsibilities.

The Content of In-service Education

Although lack of specific objectives is cited as a recurrent problem of in-service education, most in-service sessions attempt to be consistent with district goals. However, with the district-wide focus of most in-service programs, decisions must be made concerning the content of the programs. In the successful implementation of an activity-oriented middle school science program, teachers need help in a variety of areas. Because of the often large deficiencies in the content preparation of middle school science teachers, it is reasonable to expect in-service programs to allow teachers to systematically interact with specific laboratory activities, specific skills, and techniques, as well as with conceptual understandings and applications related to the program(s) used in their classrooms.

In addition, in-service programs should provide experiences that will aid teachers in implementing the philosophy and instructional strategies of their programs. The NSF teacher institutes of the 1960s and 1970s devoted much time to the nature of inquiry, inductive-deductive instruction, etc., as these related to specific programs (e.g., IPS, IME, ISCS, ESCP). Also, in implementing middle school science programs, teachers often need help in individualizing instruction; motivating children; adding, modifying, and sequencing activities; managing classrooms, materials, and children; and aiding children with reading and other special problems. How these topics are treated depends upon the district's perception of in-service education.

Closely related to the above is a problem identified by Coleman (1976) relating to how teachers assimilate information during an in-service session for use back in the classroom. Typically, someone presents a new idea, principle, or skill to the in-service group. The participants discuss the topic and its classroom applications. The in-service ends and the teachers return to their classrooms to implement the idea or skill. This process, Wood and Thompson (1980) suggest, is not consistent with adult learning. Their perusal of the literature suggests that direct and concrete experiences are an essential component for in-service education. Verbal, talk sessions are not adequate to change behavior. Joyce and Showers (1980) analyzed more than 200 studies in which researchers investigated the effectiveness of various kinds of training methods. From their analysis, the following training components were identified that alone, or in combination, contribute to the impact of a training activity:

1) presentation of theory of description of skill or strategy,
2) modeling or demonstration of skills or models of teaching,
3) practice in simulated and classroom settings,
4) structure and open-ended feedback,
5) coaching for application.

Their analysis does not appear to support the district wide focus for in-service. Rather, it appears to support the practice of in-service based on the individual needs of teachers and the direct application to the classroom. With a district's in-service program containing only components 1) and 2) above, it is understandable why the "typical" middle school science teacher has difficulty in implementing the district program.

Mobility of Middle School Science Teachers

Another variable indirectly affecting in-service education of middle school science teachers involves their mobility within the school district. Although no data are available, a general pattern of mobility on the part of both middle school science teachers with elementary certification and those with secondary certification seems apparent. As seniority is attained within a district, many teachers apply for transfers from their initial placement in middle schools to schools containing grade levels of their preference. For many urban districts this creates a unique problem in maintaining a staff trained to utilize a particular program. For example, a program such as the ISCS is very dependent upon a well-trained, experienced staff that can implement the philosophy of the program. A high mobility factor often seriously hampers the successful implementation of such a program.

Lack of Priority for Science Instruction

A review and analysis of the literature (Helgeson et al., 1977) revealed that science in the general education program is receiving less emphasis. It would appear the 1980s will continue the trend of the 1970s that placed science as a low-priority subject area in most urban districts (Stake and Easley, 1978). With decreasing NSF funds available for in-service training targeted for implementation of particular programs and the current emphasis on basic skills, science has not received adequate financial support, nor, more importantly, commitment for improvement. Stake and Easley (1978) conclude that schools are "no longer providing a spokesman for science." They suggest that curriculum coordinators are doing important things, but are not speaking out about the importance of science.

Selection of Training "Expert" for In-service Programs

Rubin (1978) raises the question of who should serve as the training "expert" for a district in-service program. In addition to the political issues suggested by the question, especially for urban districts, the question has a practical dimension. For example, if the training expert consistently comes from outside the district (often the case if the district has no science supervisor), problems arise in in-service approaches going beyond the "communication of theory" component identified by Joyce and Showers (1980) in their review. Little opportunity for feedback and supervised classroom application of ideas and skills gained from the in-service programs exists. This is particularly important to middle school science teachers who need concrete experiences beyond the initial communication of ideas.

Lack of Rewards and Incentives for the Career Teacher

Over the years, the author has observed many career science teachers who, after a number of years in the classroom, become frustrated and/or bored. In many instances the problem is created by a teaching environment consistently devoid of "appealing" rewards. Solomon (1980) suggests that teacher participation in in-service programs can spark enthusiasm and gain badly needed recognition for such teachers. In any district many science teachers are constantly implementing new ideas and techniques in their classrooms. Too often, however, there is little recognition of these efforts by their administrators. Again, this is especially true if the district is without a science supervisor who recognizes such exemplary efforts. While monetary benefits are appealing to most teachers, certificates of merit, letters of acknowledgment, and invitations to communicate their ideas and programs to science teacher meetings and in-service groups will also provide strong incentives for teachers. Increased use of rewards and incentives might well keep many middle school science teachers from changing grade levels and teaching responsibilities at the first opportunity.

This section has been less than positive. In those individual schools and districts where active, ongoing in-service programs are the rule, much of what has been said is not appropriate. The importance of the science supervisor to the success of an in-service program has been strongly suggested.

While there is a greater percentage of urban school districts with science supervisors, the supervisors are faced with sizable problems in performing their functions. For districts with no supervisory expertise in science, the future is not bright.

CURRICULUM PROBLEMS

There would appear to be subtle effects of current curricular programs on the in-service programs for middle school science teachers. Since Sputnik there has been an evolution of a wide variety of middle school science programs. In selecting programs, teachers observe the lack of agreement on "what knowledge is of most worth?" and on the "proper" sequence of courses for the middle grades. Deciding whether to follow the Guidelines for Development of a Life Sciences Program (Hurd, 1969) or the rationale for the ISCS program (Intermediate Science Curriculum Study, 1972), for example, in developing a local middle school program, reinforces this lack of agreement.

Additional concern occurs when teachers discover that (1) their adopted program does not interest a large percentage of their students, (2) their adopted program does not "work" with nonreaders or other "types" of children found in their classrooms, or (3) they have serious limitations in their ability to implement the program in their classrooms (Butterfield, 1976a). These concerns can usually be resolved only through adequate in-service experiences and supervisory expertise to provide teachers the leadership necessary to modify programs and develop specific competencies.

Because of the desire to provide continuity among a number of middle schools within an urban district, district personnel and teachers often identify a scope and sequence of objectives that apply to all middle schools. Programs and/or curriculum guides are identified or developed to implement the objectives. There are some limitations to this strategy.

In implementing a topic from one science program (BSCS Blue Version), Gallagher (1967) concluded that because of the wide variability in content emphasized and in teaching behaviors, there is no such thing as a BSCS Blue Version program. There are as many versions as teachers. In a study examining the effects of long-term implementation of the Elementary Science Study (ESS) in New Orleans Public Schools, Beisenherz (1980) observed that teachers differed greatly in their utilization of ESS materials. For some teachers, the ESS philosophy and strategies were consistent with their teaching styles. For others, the philosophy and strategies were "tolerated" but modified, and for a few teachers, the ESS philosophy and strategies could not be incorporated into their teaching styles.

The Intermediate Science Curriculum Study (ISCS) is unique in many ways when compared to other programs. The above studies suggest that not all middle school teachers would perceive and teach the ISCS program in the same manner. It is highly questionable to expect that, in all cases, teacher style can be significantly altered to match program philosophy and objectives. Rather, serious efforts should be made to match specific teachers and their unique styles and personalities with specific programs to be used in their classrooms and schools. The above has strong implications for in-service efforts and the necessity to further individualize both the textbook selection process and the in-service programs to accomplish individual teacher needs.

STRATEGIES FOR SUCCESSFUL IMPLEMENTATION

As suggested above, middle school science teachers form a highly variable population within an urban school district. These teachers and their district in-service programs possess strengths and weaknesses that contribute to the overall success of the science program. From the above discussion, the following elements should be present in the district's in-service strategy:

1) District goals and objectives for the middle school science program must be identified with direct input and support of middle school science teachers.

2) Strong financial and moral support and encouragement for science instruction must exist from the school principal and district personnel.

3) Strong leadership should be exerted within the district by personnel possessing expertise and strong commitment to science instruction.

4) There should be a broadly conceived, highly experiential, individualized in-service program that meets the needs of all teachers. These experiences would deal with the specific goals, content, strategies, activities, and unique problems of management, individualization, etc., characteristic of the program(s) used by individual teachers within the district.

   There should be an attempt to provide experiences led by individuals (classroom teachers, university personnel, etc.) who are, or have been, directly involved with particular programs or approaches used by the school or district. As Voelker (1977) suggests, successful in-service education involves working with teachers in developing ideas and techniques in response to local needs rather than having teachers learn to use specific materials or programs. It would appear that both approaches can be utilized (often simultaneously) by science teachers pursuing similar objectives within a school or district.

5) In addition to the communication of information, the in-service program should include feedback, modeling, and coaching experiences that will encourage the integration of in-service training into the classroom setting.

6) In-service education should be an ongoing process. McIlwaine and Ziegler (1977) suggest that innovative programs require a minimum of two years in-service experience and depend primarily upon meeting teacher needs and concerns. After reviewing studies of in-service education, Mallinson (1977) stated that while changes do occur through in-service education, the stability of these changes beyond a year is questionable. In districts where teacher deficiencies are present and where middle school science teachers are highly mobile, in-service experiences must be continually provided for successful implementation to occur.

7) There should be an attempt to match particular district science programs with specific teachers and with their various interests, capabilities, personalities, etc. Because of the high mobility of middle school science teachers in many districts, teachers considered for vacancies in schools with activity-centered programs (e.g., ISCS), must be carefully screened. To place teachers lacking the personality factors and/or the commitment to program philosophy can only endanger successful implementation in the school.

8) Building principals must be encouraged to assume a leadership role in science curriculum development and implementation in their schools. They must communicate to their teachers both a high priority for science instruction and an expectation for their participation in experiences (workshops, courses, conventions) that provide opportunities for professional improvement in science instruction.

9) Mechanisms should also be present within the district to recognize and reward those science teachers who are successfully implementing programs, ideas, and techniques in their classrooms.

10) Within the urban setting, there often exists an opportunity for a district or individual school to work closely with a local university in a joint preservice-in-service venture. These efforts can be initiated by the university science educator, the district supervisor, or the individual building principal or teachers. The potential positive symbiotic relationship between both preservice science teachers and middle school science teachers in an urban setting is obvious.

11) One or more facilities should exist within the district to serve science teachers. These "centers" can serve as a resource for materials used in developing and modifying activities and social issue case studies, culturing and maintaining organisms, developing competence in laboratory skills and techniques, etc. These centers can serve as a "base" for the individualized in-service programs suggested above.

There are many models or strategies cited in the literature that possess one or more of the above elements. The models can be divided into two groups. For the interested reader the following are some of the many sources for each group:

1) Those models that have been implemented in one or more actual teaching environments (Garner, 1976; Rubin, 1978; Sheldon and Yager, 1978; Stachowski, 1978).

2) Those models of a conceptual nature that have not yet been applied, <u>in toto</u>, to the classroom (Benson, 1975; Butterfield, 1976; Ellis, 1975; Horn, 1975; Hurd, 1969; Speiker, 1978; Voelker, 1977; Wilson, 1978).

Through the use of a monograph, AETS could identify, describe, and communicate current exemplary in-service science programs that utilize effective strategies identified in the literature. A critique of each program could help practitioners further develop successful programs within their districts or schools.

SUMMARY

This section of the yearbook, like most of the literature reviewed by the author, has a rather pessimistic outlook for in-service education, especially for science teachers. However, Rubin (1978) suggests that educators should attempt to convey an optimistic rather than pessimistic view of teacher growth. He states that a "belief in the capacity of teachers to grow, to reach increasingly higher levels of maturity, and to serve youth with greater compassion, skill, and understanding, is, perhaps, what will make the greatest difference" (p. 40). What will, and must, follow this view is an increased commitment on the part of principals and other administrators to provide the most appropriate experiences for their staff. Given optimum conditions for professional growth, teachers have the ultimate responsibility for personal growth that will maximize their teaching effectiveness. As King (1975) suggests, "professional growth must be re-imaged as something the individual does to and for himself rather than something imposed upon him by the system" (p. 93). The teacher is the key.

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IMPROVING PRACTICES THROUGH INSERVICE: A MODEL FOR TEACHER INSERVICE TRAINING DESIGNED TO OVERCOME GEOGRAPHIC PROBLEMS

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INTRODUCTION

At a time when the public eye of social conscience is focused on the inner city, it is difficult to remember that nearly half the people in this nation are still rural. Although official sources report we are 75 percent urban, this is usually calculated on the basis that any town over 2,500 is "urban." If calculations are done using a definition of populations of 25,000 or more being considered urban, the rural population of this country is almost 40 percent.

This means there are perhaps 70 million rural Americans, the number depending on one's definition of rural. And, according to Bost (1969): "The inadequacies of education are nowhere more apparent than in the equality of science instruction in our rural schools and they are especially evident in this field because adequate facilities, curriculum leadership, and competent teachers are in such short supply in rural schools" (p. 43).

Many middle school youngsters living in rural areas have never visited a science museum, never met a scientist, never really done a science investigation. The Second Handbook of Research on Teaching (Travers, 1973) goes so far as to label these youngsters the "rural disadvantaged"--a group often "left behind" economically and socially (p. 711). And, rural middle school teachers are generally not prepared to conduct investigative or inquiry-style science programs, nor do they have the materials needed to do so. According to Bost (1969),

> Rural America does not have first-rate science laboratories and highly skilled teachers of science, and we are talking pie-in-the-sky if we believe we will have them in the near future. We believe the greatest gain can be achieved by taking the best rural teachers we have, upgrading their competence through additional training, and maximizing their effectiveness... (pp. 43-45).

With a geographical area of 97,914 square miles and a total population of only 450,000 people, Wyoming is one of the most rural of the 50 states. One- to four-room schools are still common, and the "average" Wyoming middle school is staffed by

6-10 teachers. The typical middle school teacher in Wyoming lives several hundred miles from the University of Wyoming, the only source of on-campus in-service training for teachers provided in the entire state.

Difficulties of providing teacher in-service training over vast geographical expanses are compounded by long and harsh winters, where even the most major highways and airports are frequently closed because of snow storms.

An attempt to overcome these many obstacles to in-service training was initiated in 1970 by the staff of the Science and Mathematics Teaching Center (SMTC) at the University of Wyoming. A comprehensive grant was awarded to the SMTC by the National Science Foundation (NSF), which provides support for SMTC staff to develop a workable in-service training model for vast rural areas such as Wyoming. As a result, the SMTC Portal School Program was developed. The program is still very much in existence today, providing in-service training to many hundreds of teachers yearly in science, mathematics, and energy education.

THE PORTAL SCHOOL PROGRAM

The Portal School Program is a means whereby a school district uses the resources of the University's Science and Mathematics Teaching Center to provide assistance to teachers in implementing curricular changes. The school district becomes a "portal" through which the staff of the SMTC and teachers from the school district provide workshops, consultation, and other support services for teachers. In typical university courses and extension courses, the university works directly with teachers who are motivated to participate by their personal needs and interests. In contrast, the Portal School Program is a means of working with teachers to develop a plan to respond to specific <u>school district</u> needs.

School districts in Wyoming and neighboring states may opt to contract with the SMTC to develop portal schools tailored to their local curricular and in-service needs. Three phases typically occur in the development and operation of a portal school:

<u>Phase I</u>--Needs of the school district are assessed by a team composed of school district administrators, teachers, and SMTC staff members. A general plan of action is developed by this team.

<u>Phase II</u>--"Portal leaders" from the school district are identified. These leaders are teachers who will be given intensive training, normally during the summer, at the SMTC on campus. These portal leaders then

conduct in-service courses for their colleagues on site at the local school district. Thus, there is a "multiplication effect" built into the Portal School Program where instruction given to small groups of leaders is duplicated with much larger groups of teachers at the local level.

Phase III--Teacher workshops are conducted and curricular changes are implemented "on location" at the school district. SMTC staff visit as needed and are available to conduct a small portion of the in-service instruction. At the end of this phase an evaluation of each specific portal school is conducted.

OPERATION OF THE PORTAL SCHOOL MODEL

The Science and Mathematics Teaching Center (SMTC) of the University of Wyoming is the focal point of the Portal School Program. The SMTC was established to improve the preservice and in-service training of science and mathematics teachers. The in-service component is performed primarily through the Portal School Program. The center contains curriculum materials and supplies and has facilities for working with materials and demonstrating their use to teachers. In addition, faculty members conduct research and development activities on various problems of science and mathematics instruction and the learning process.

The SMTC receives its operating budget through the College of Arts and Sciences but is staffed jointly by the College of Arts and Sciences and the College of Education. The courses offered by the SMTC, both preservice and portal school courses, are listed in the Department of Natural Sciences. This department does not have a staff or budget and exists only as a mechanism for offering courses in science education. This arrangement provided the SMTC with the opportunity of defining courses for the Portal School Program so they could meet the needs of elementary and secondary science teachers in their specific situations.

A major feature of the Natural Sciences course descriptions is the flexibility of content which may be presented in the courses. Hence, different middle school workshops with the same course number may cover, for example, (1) exploration of the ESS, SCIS, and ISIS curricula; (2) exploration of the ESS and ISIS curricula; (3) implementation of the ISIS curriculum; and (4) implementation of the SCIS curriculum, etc. Another aspect of the flexibility is that courses are defined with variable credit.

A second major feature of the course descriptions is the emphasis on application in the science class. The descriptions convey the idea that a middle school or secondary teacher who has had successful experience in using the curriculum materials would be most qualified to teach the course. This idea coincides, of course, with the portal school design--using local teachers rather than university professors as portal leaders.

The SMTC carries out all of the financial transactions associated with the Portal School Program. It collects the tuition from workshop participants and makes disbursements to the Extension Division (for course registration and recording on transcript), portal leaders (for salary), and a reserve fund (for subsequent portal school activities).

One staff member of the SMTC (Mr. Vincent G. Sindt) is full-time coordinator of the Portal School Program and is responsible to school districts. To start a portal school, a school district is first asked to identify its needs in science instruction. Then the coordinator assists the district in formulating a general plan for exploration, implementation, or creative expansion of science curricula. Stressing the importance of financial and leadership support from the central administration of the schools, the coordinator seeks a commitment from the school district to support the program before continuing to the second phase. Although portal schools generally are established within school districts, several portal schools at the middle school level serve multiple school districts in a region.

After the district makes a commitment to the program, candidates for portal leaders must be selected for training and certification. A small district may need only one portal leader whereas large urban districts may need 20 or more leaders. In many cases the portal leader candidate is a teacher who has previously participated in an NSF institute and has already implemented curriculum changes. In other cases a teacher is selected because leadership has been demonstrated in science education or some potential for leadership has been exhibited. The coordinator selects portal leader candidates after asking the science supervisor or the central administration for its recommendations and then observing the teacher's interaction with colleagues. Reactions from students are also considered.

The leadership training is accomplished through workshops which are conducted in the summer at the University of Wyoming. They last from one to six weeks, although the average is about three weeks. There are four parts to the leadership training workshops:

1) An "open lab" where the teachers explore new curriculum materials.

2) Seminars on contemporary educational issues; topics included are theories of instruction,

recent psychological research findings, and the nature of early adolescents.

3) Low-risk group dynamics exercises.

4) Planning the teacher workshops for the local school district.

After successful completion of the leadership training, the portal leader is certified by the SMTC. The certification entitles the portal leader to conduct a specific course for which a plan has been approved by the SMTC. The certification decision is based primarily on the faculty's judgment of the candidate's ability to perform as a workshop instructor.

The major activity during the third stage consists of district-level in-service workshops for local teachers. Initially there must be publicity about the workshops and a survey of teacher interest. This may be done by a portal leader, a science supervisor, or someone else responsible for curriculum and instruction or professional development of teachers. The SMTC must then approve the specific workshop plan. Faculty members check the workshop proposal for balance and determine if the teacher interest level is sufficient to warrant a workshop.

The teacher workshops generally meet once a week during part of the school year, with meetings in the evening or late afternoon. Some workshops meet during the summer. Teachers are registered for the course through the University Extension Division and receive one to three graduate credits. The focus of the workshop is related to the school district needs which were identified in stage one. Three levels of focus have been specified for the teacher workshops: exploration, implementation, and creative expansion.

Level I: Exploration

In the first level, teachers explore alternative science programs and methods of instruction. They are introduced to new equipment and teaching materials which are commercially available for use in the schools. The materials used in the workshop have either been purchased by the school district or have been loaned to the district by the SMTC. In many of the workshops, teachers are also encouraged to check out materials and try them with their classes.

The main goal of the exploration workshops is to help the teachers understand the alternatives available to them in their science instruction. Hence, they should be better informed when making a decision about the adoption of a science curriculum. The teachers also learn new science content by working with the curricula in the workshops and their classes.

Level II: Implementation

The second level workshops are designed to prepare teachers for implementing a new curriculum. A science curriculum which has been adopted is studied in sufficient depth so teachers can implement it without serious problems. In many workshops, most of the time is spent by teachers in working with the materials in the same way that students do. Some portal schools start at the implementation level because the adoption decision had already taken place before the portal school was established.

Level III: Creative Expansion

Although there are no portal schools functioning as yet at the level described as "creative expansion," it is envisioned that such workshops will occur after a curriculum is implemented in a school and used for a certain amount of time. As participating teachers express an interest in developing creative ideas for modifying and expanding the curriculum to provide for more student flexibility, level III workshops will be organized to facilitate these changes.

The portal school program is financed chiefly through tuition paid by workshop participants. In about half of the portal schools, the school district pays all or part of the tuition for the participants. Thirty percent of the tuition is used to pay the portal leaders. Forty percent goes to the revolving fund of the SMTC for administrative costs of the portal school program and the activities of the center. For example, the materials loaned to the portal schools for exploration workshops are purchased with these funds. The remaining 30 percent is set aside in a reserve fund to be given back to the portal schools for financing subsequent activities. For example, a school may use money in the reserve fund to pay part or all of the tuition for level II or III workshops or to supplement the salaries of portal leaders.

MERITS OF THE PORTAL SCHOOL PROGRAM

During the past 10 years of portal school operation, continuous monitoring of the program has been maintained. Formal evaluation on questionnaires has been completed by virtually all teachers who have participated in portal school in-service training. At this point data have been collected from some 10,000 teachers, and this information is stored in a computer bank. Likert Scale responses to the various aspects of the program have been collected using a scale of 1 (strongly negative) to 5 (strongly positive). Of the 26 aspects of the program rated by the thousands of teacher participants, more than 80 percent of these aspects have been given an average rating of greater than 4.0. The remaining 20 percent of the items have an average rating of between 3.5-4.0. These data leave little doubt about the effectiveness of the program from the teacher's point of view.

To summarize our experiences with the Portal School Model, we see five major strengths of this approach to in-service training.

School District Responsibility

Participation in the Portal School Program requires the school district to identify its local needs in the area of science instruction and to develop a program which will respond to these needs. The merit of this approach is that the portal school then becomes a school district program. It is not a program where the university provides instructional services directly for teachers' needs and interests, but it is a program where the school district can use the resources of the university to provide an inservice program which meets the school district's needs. Hence, there is a school district commitment to the program and responsibility for the school district to support the program to the extent that is necessary for its success. The Portal School Program is designed by the university to have the flexibility of responding effectively to the needs of each school district. Hence, the design and intended outcome of a portal school in one district may differ from the portal school of another school district.

Local Leadership

The success of a portal school depends, to a great extent, on the portal leaders. Since many of the portal leaders are recognized by their colleagues as science education leaders in the district, their credibility is already established. Commenting that the portal leaders are using the new curriculum materials themselves and that they understand the problems in using the curricula, teachers have responded quite favorably to the use of local teachers as portal leaders. This local leadership is developed further through the leadership training sessions and the subsequent planning and conducting of teacher workshops. The portal leaders also perform as science resource teachers in the schools in addition to conducting the workshops.

Practical Orientation of Workshops

A third merit of the Portal School Program is the practical orientation of the workshops. Teachers are able to develop competencies which are immediately applied in their science classes. Many of the workshop activities consist of teacher experiences with the materials that are used in new curriculum packages. Some of the school districts encourage the teachers to check out these materials to try them with their classes while they are enrolled in the workshop. The teachers have reacted quite favorably to this feature. Since many teachers are reluctant to change their teaching styles, it is important to give them as much encouragement as possible and to make the transition as convenient as possible. There is evidence that the portal schools are capable of doing this.

Geographical Scope

The portal school program provides the opportunity to introduce and implement new curriculum materials simultaneously in many school districts and over a large geographical area. This is achieved, of course, by using university resources to train local teachers who then train other teachers in the school district to implement the curriculum materials. Universities do not have the resources to conduct teacher workshops in multiple districts at the same time and in such a large geographical area as is being done in the Wyoming region, but they do have the resources to train leaders from the school districts who in turn can be the portal leaders within their school districts. For this reason the Portal School Program seems to be one of the better systems for meeting the needs of sparsely populated areas which are remote to the university.

Responsiveness of University to School District Needs

The Portal School Program is capable of promoting strong relationships between the university and school districts. Generally, universities have responded to the needs and interests of individuals rather than the needs of educational units such as school districts. Through the Portal School Program, the University of Wyoming is working closely with the central administration staff of the school district to develop a program which meets the district's needs in science education. Hence, the university is responding to school districts in a way that school districts have frequently requested but have infrequently obtained. A key factor in the responsiveness of the University of Wyoming is the organization of the science education faculty in the SMTC. Experience has indicated that it is difficult to coordinate the resources of faculty unless they are committed to the program through some formal organization like the SMTC.

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CHAPTER X

IMPROVING PRACTICES IN MIDDLE SCHOOL SCIENCE: REACTIONS FROM THE FIELD

REACTION I

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The most pervasive, and potentially the most positive, theme of what has been written in the preceding chapters is the uniqueness of the middle school. The recognition of the distinct identity of the middle school necessitated by the diverse needs of the early adolescent learner has, and will, impact upon science education in a myriad of ways. The future of science in the middle grades--in terms of its curricular priority and relevance for learners--is clearly contingent upon the sensitivity and subsequent action of science educators in response to the emerging middle school concept.

The recurrent dimensions of this theme, as discussed by several contributing authors, revolve around a common hypothesis: The catalyst for achieving successful science education is clearly the classroom teacher. It is our firm belief that the attitudes and perceptions of science teachers toward their role in the classroom far outweigh any effects that come about as a result of changes in curriculum. Therefore, it is our contention that such a hypothesis is not simply valid, it is imperative for the success of science education. Such a challenge is indeed a complex one, and one which will require a closer scrutiny of the change agents needed to stem the decline of science in education. The outcomes that occur at the middle school level will greatly affect the quality and quantity of science programs at the secondary level.

The strategy to achieve an improved standard of science education must resolve, initially, two central questions:

1. What is the role of science in the middle schools?
2. What is the role of science teachers in middle schools?

In response to the first question one must accept the assessment of Cleminson et al., that the regrettable "back to the basics" movement has had a regrettable effect upon science education. The issue of whether science is basic to the schooling process is an important one, and one that we as science educators have failed to adequately defend. It is simply not enough for us to agree among ourselves that science education is important to the developmental process of the adolescent learner. We must assume an aggressive posture and actively promulgate this position.

Another reason for the tenuous position of science education in the middle schools may well be linked to educators themselves, with specific reference to their conception of the role of the discipline. Many of the authors clearly underscore what middle school science education should not be--not product oriented, limiting, specialized, or dichotomized. What, then, should it be? Each author, in a variety of ways, correctly envisions science in the middle school as a facilitative process for a spectrum of tasks. Certainly, as provided for in both the Georgia Certification Plan and Memphis State University Preparation Program, science must place a priority on sequenced and functional foundations of knowledge. Development of skills continua, however, is not enough. Closely correlated and equal to skills continuua, if not more important, is the emergent dimension of thinking skill development in a curricular context.

There seems to be agreement that middle school youngsters come to science class (or any class for that matter) with a wide range of cognitive abilities. A number of curricular approaches since the early 1960s have concentrated on providing students with laboratory experiences. However, these experiences, with few exceptions, have not been correlated closely with current learning theories of adolescent development. In fact, they have often been a major stumbling block, causing many teachers such anguish that they have ceased providing students with any laboratory experiences at all.

Other changes have also occurred in the past decade. We would agree only in part with the statement by Penick and Lunetta that, other than materials, little has changed in the classroom. There has been a substantial change in the composition of the classroom unit. In the Seventies we moved away from homogeneous groupings of students in favor of more heterogeneous groupings. Added to that have come a number of state laws which advocate mainstreaming of special education youngsters in "the least restrictive environment." While these youngsters may have been receiving remedial help in reading, language, arts, and math, many have been added to the rolls of science classes. We strongly support this move as being in the best interest of the youngsters, but declare an urgent need to revise curriculum programs and assist teachers in acquiring the needed skills to modify existing programs. The science education programs of the

1980s should concentrate on the nature of the learners and how their needs can best be met. We must fit the program to the child, not the child to the program.

The assumptions that we make about adolescent learning potential are central to any new curricular designs or the modification of old ones. Fitting the program to the child does not necessarily presume that learning takes place only when the environment is altered. The research of Dr. Reuven Feuerstein (1980) suggests that there is a method by which one can modify the cognitive abilities of the child. While his program has been aimed at what he terms the "retarded performer" (p. 3), his methodology has considerable implication for teaching the transescent. Dr. Feuerstein suggests that the individual is plastic in terms of his cognitive performance and that through a "mediated learning experience" (pp. 37-70) the individual's cognitive abilities can be modified. If science education is to assume a leadership role in the development of educational programs that are learning theory-oriented, it must examine closely all research in that area.

We proffer two additional dimensions to addressing "What is science in the middle school?" These are positively and appropriately advocated by the contributing authors of this yearbook:

1. Science must be seen (as noted by Erb) as an integral component, not a separate entity, of an interdisciplinary curriculum.

2. Science must emphasize its prominent role in the "other" side of education.

The first dimension strongly correlates with the aims and philosophy of the middle school. Science educators should develop and incorporate activities and units that integrate science with other subject areas. Traditionally, thoughts of interdisciplinary teaming have centered around science and mathematics. While there is nothing inherently wrong with this union, we propose that other subject areas--primarily social studies--might be more easily integrated. As Yore has pointed out, it is important to consider the "compatibility of the nature of the learner" with the subject area and the teaching strategy. Most middle school programs consist of a general science, a life science, and an earth science course sequence. The type of thinking utilized in these subject areas is generally inductive in nature. Since the way mathematics is usually taught tends to be deductive, it would seem that science in the middle grades might be more effectively integrated with social studies. This is not to say that we don't see a need for deductive activities such as predicting, designing experiments, controlling variables, and interpreting data. We do, but it must be remembered that middle school students are in the early stage of cognitive development that allow them to perform those operations.

The second dimension mentioned is concerned with the development of an educational program that involves students in their "total personal development." The process of education in science should cause a series of outcomes that are affective in nature. We strongly agree with those who have enumerated the importance of students listening to others, accepting the viewpoints of others, becoming aware of their own feelings, and becoming aware of the values of self and others. There needs to be social interaction at this age level. Group-oriented work can encourage the above-mentioned skills and help to break the egocentricity that is so much a part of the nature of the adolescent. Whether one defines this "other" side as Goodlad's "high" literacies (1979) or the humanism of Abruscato and Hassard (1976), it does demand that science teachers expand their traditional role.

A redefinition of the role of science in the middle school must result in the resolution of the second main question posed by these articles: "What is the role of science teachers in middle schools?" Many of the perceptions of the developing role of the science teacher, as espoused by the contributing authors, are accurate, comprehensive, and provide for a clear direction for action.

The most significant and fundamental change that is suggested is that the middle school science teacher does not teach a subject; he/she teaches students--students who in their diversity call for teachers to accept a multiphased realm of responsibility. It means, initially, that teachers must redefine the role of science itself, as described in the preceding comments. It means that science teachers must accept their role capacities as student advisors, team members and resource agents, and not as just instructors.

Each author details, and appropriately so, a cadre of "technical" skills required of successful science educators. Particularly significant, in our opinion, are those dealing with teaching via learning styles and accurate assessment of student needs. The role of the science teacher, then, should be that of a manager, a facilitator of learning.

The degree to which this occurs, however, would appear to depend on the professional and personal experiences of the teacher. We would agree that the science teacher must be involved in such pre-instructional activities as allow for identification and implementation of inquiry programs and practices that encourage presentation of concepts. These should be in as concrete terms as possible. However, teachers must be adequately trained to do this. It may be an error to assume that teachers know how, or have been adequately taught, to manage an instructional program in this way. Much has been stated about the need for classroom teachers to address themselves to the growing needs of the adolescent. Where, however, are the examples or training by which a teacher learns how to teach students how to ask questions, critically analyze or reserve a conclusion, or make a value judgement.

We are a product of our experiences, and most teachers have experienced only the expository mode in their own learning. Science educators must model the instructional techniques considered desirable. Careful coordination of lessons that develop both inductive and deductive processes are important. This, as Yore states, is a considerable responsibility. This also may be a responsibility that is beyond the educational training of most middle school science teachers.

It has been suggested that the development of inquiry strategies and activities that build upon students' strengths and previous experiences is fundamental to the development of new logical thinking skills and processes. We agree with these statements but must conclude that the identification of these important truths is not enough. It must not be assumed that, because research has made known these fundamental principles, that is all that is necessary to change the course of science education.

The style of teaching espoused in these chapters would require some time to perfect. A teacher first trying to implement divergent and open-ended teaching strategies could become frustrated if his/her students had never before experienced this kind of classroom environment. Patience is a virtue which not all of us have. Asking teachers to analyze a program for the level of reasoning required is very optimistic for those who have not had extensive training in that process.

Both preservice and in-service education needs to be scrutinized closely if middle school science is to become an effective and viable experience. Reaching teachers early is crucial. The Iowa UPSTEP model program, as described by Penick and Lunetta, sounds promising. However, programs of this nature must be nation wide if they are to have any effect. The student teaching phase of the preservice training is especially important. The new teacher must have an experience that allows him/her to see the connections between reality and theory. Placing student teachers in a less than exemplary situation only compounds our problems.

We must also consider the certification requirements for middle schools. More than half of the middle school teachers in this country have elementary school teaching certificates. Too often, the science courses required for elementary certification do not adequately prepare a teacher to teach science. Yet science teacher positions are filled by teachers with only a general elementary certification. This is compounded by the problem that many middle school teachers certified in science do not have the adequate training in the broad general topics of middle school science courses.

As several contributing authors have suggested, in-service education should be centered around, and responsive to, the needs of individual teachers relative to their specific programs. This should include more than the usual potpourri of "how to" courses. There should be time for follow-up activities, feedback, the implementation of newly acquired skills, and an opportunity to see programs modeled. Mediocre in-service programs planned by a school system are antipodal to constructive changes desired by competent science educators. Teachers must be involved in the planning of their own in-service programs; and, as both Beisenherz and Erb point out, the involvement of experienced teachers is crucial. This may serve, at the same time, as much needed recognition for a job well done. Beisenherz's idea of communicating exemplary in-service science programs is a good one and should be implemented.

It has been noted (but in a somewhat cursory manner) by several authors that the attitudes of teachers are the real determiners of instructional growth. Certainly the plans for preservice training with emphasis upon broad-based classroom and field experiences and the staff development philosophy which includes the learner (teachers) in determining the process are indisputable in their merit. We would underscore again our concern that each plan, while making commendable initial steps, must continue the commitment to prepare teachers not just to teach middle school science but to teach middle school students as well.

Science in the middle school: will it be relegated to something "nice to do late in the afternoon while waiting for the school day to end;" will it remain as a distinct discipline, important to the future of some students but limited in its relevancy to others; or will it achieve its potential? Is that potential to become <u>The Whole School Book</u>'s "rushing universe of events" for middle school learners? If science education's future in the middle school is to reach its potential, it will be because the authors of this yearbook are joined by others in the recognition that teachers will be the agents who ultimately determine the fate of the discipline. It is, then, the responsibility of us all to enable teachers to meet this challenge.

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IMPROVING PRACTICES IN MIDDLE SCHOOL SCIENCE: REACTIONS FROM THE FIELD

REACTION II

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For far too many years, the middle/junior high school has been a stepchild in public education, assigned a second-class role in the minds of the public and in the minds of too many teachers. For far too many years, teachers at this level have been inundated with rhetoric that lacks concrete direction. The Association for the Education of Teachers in Science (AETS) is to be commended for its leadership in recognizing the middle school as a viable force in the education of this segment of the nation's youth.

Science education at all levels has been subjected to tremendous amounts of criticism in today's world. Newspapers have carried an endless number of headlines warning the public about the "crisis" and "decline" of science education in our nation's schools. The "back-to-basics" movement has been eating into science everywhere, and particularly at the elementary and middle school levels. This nation has recently entered a complex technological age: an age that to most people was hardly a dream just 20 years ago; an age when students are most in need of a good science education program to prepare them to take their places in this world.

Although not the subject of this paper, this mood of public distrust toward science education must be stated here to place the contents of this yearbook into proper perspective. Influencing educational change in science during times like these is difficult, to say the least. It seems as big a barrier at times as landing on the Moon was once thought to be. But man did land on the Moon! Keep in mind that this paper was developed from the point of view of a classroom teacher--one who has spent the better part of a life-time in the science classroom, living and learning about science education at the ground level, and perhaps even influencing its change once in a while. Although the facts may be the same no matter what the point of view, the point of view will certainly affect the interpretation of those facts.

A glance at the history of science in the middle/junior high school in recent times shows that in the early 1950's science was still thought by the public to be a form of magic--a mystery. The public didn't understand science and was afraid of it. The nuclear age had dawned on the world, and the public saw this nuclear power through the eyes of fear. Further, people believed that scientists were concerned only with this incredible force. pride was hurt; suddenly, the country looked upon science and science education as the answer to many, if not all, of our problems. Science reigned supreme. The National Science Foundation promoted science and science education, funding became available, new materials and new programs were developed, and teacher education programs proliferated. It was a very exciting time in science education.

Well, the days of Sputnik and its influence are long behind us and science education is back to promoting itself, in some cases to hanging by threads. Not only has science education had to resort to promoting itself, it simultaneously has had to fight off the "back-to-basics" movement, program elimination in the science disciplines, the effect of declining enrollments on science courses, public distrust of science, the general apathy of the public toward all forms of education, etc. The list seems endless and difficult to battle. However, a resurgence of the role of science in our society seems to exist. And none too soon if we are to live in the complex technological society that appears to be our future. It is imperative, under these conditions, that science make a strong comeback now.

Although science was a part of many junior high school curricula in pre-Sputnik days, it was during the post-Sputnik era that science education really established its importance at this level. The emphasis shifted from pure content to content and process in that span of time. Reflecting this change, new text books were written, new programs were designed, and innovation was rampant. Everything was "A-OK" and "go" for science education in those days. But, as is only natural following a period of such euphoria, just as everything seems to be rolling along smoothly someone calls for an examination of the value of all this time, effort, and money. At first, science educators questioned the need for such evaluation. Why couldn't everyone see that science was still very necessary, that there was still a long way to travel? But the stronger voices were heard and external influences brought the hope of the future to a slow walk.

Many junior high school science programs were reduced or cut back, and some were even eliminated in this time period. The emphasis in the schools shifted, and junior high science teachers found they too had to shift. Simultaneously with this change came additional research data about the early adolescent and his/her activities in the science classroom. The need for additional changes became more apparent. The purpose and role of the junior high schools were challenged. Other challenges were mounted against the movement of "higher-level" content courses into the eighth and ninth grades; the emphasis on counting junior high school courses toward graduation; emphasis on grading practices. These have all been seen by some as signals that a realignment of elementary, junior high school, and senior high school discussions was needed.

Although there are a number of references in this yearbook to the philosophical beginnings of the middle school with more than 4,000 middle schools reported operating in 1978, it should not be forgotten that much of the present middle school popularity is not because of philosophical or theoretical reasons, but because financial problems and declining enrollments have plagued so many of our nation's schools, placing the ninth grade in the high school, and combining the sixth, seventh, and eighth grades under one roof. This enables the closing of a building and the elimination of all costs attached to keeping the "extra" building open.

This is not to deny that the middle school has a real basis for being, but rather, to point out how unfortunate a situation it is when external events are required to bring about what those in the profession already believe to be sound educational practice. Based on documenting this yearbook and found elsewhere, it appears that, educationally, the middle school is here to stay. Where the junior high was considered a mini-high school, or simply a transition school with loosely stated goals, the middle school is aimed more at the student and the real needs of the student. The middle school is one of those grand designs that was conceived for wrong reasons, but ultimately retained for the right reasons.

The publication of a scholarly yearbook about middle school science shows the amount of concern that has been generated. One need read no further than the first chapter to be impressed by what is known about the middle school and the students who live there seven hours a day. But by the end of Chapter six, one is overwhelmed by the abundance of information and knowledge that has been accumulated about the middle school and its inhabitants. The remaining chapters indicate that change has begun. They also indicate that there is a long way to go. The merger between theory and practice in the middle school science classroom apparently has only begun.

A middle/junior high school teacher might say that those in the "ivory tower" have finally learned what education in the "trenches" is all about. This may seen like an unfair statement at first, but actually, it is intended as a compliment. For many years, middle/junior high school science teachers have been stating that the middle/junior high school is a unique place, with unique students, having unique needs, and requiring the attention of unique teachers and programs. Most middle/junior high school science teachers know, by experience, just how unique this situation is, but when they looked for help, it wasn't there. Although it is long overdue, that help seems well on the way.

Those science teachers who have made a career of teaching at the middle/junior high school level have long been aware of the differences that separated these students from students at grades above and below them. What these teachers did not know, but wanted to know, was how to bring about or implement needed changes. It is hoped that this publication will serve as a catalyst, stimulating creative individuals to explore and design systems for synthesizing all that is presently known into innovative applications for immediate utilization in our nation's middle school science classrooms. Ultimately, it will take a partnership between those in the "ivory tower" and those in the "trenches" to effectively and positively change science education at the middle school level. That this partnership has already begun seems well documented by this yearbook.

Among the major questions to be resolved are: Where should emphasis for change be placed? Where is change most needed? And, where should change first take place? Those interested in methodology would place the emphasis on that. Those interested in curricula would place the emphasis there. Others would place the emphasis on teacher preparation, while some would stress in-service training. Psychologists would stress the student and his/her ability to grow and learn in his/her environment. Is one emphasis more or less important than another? Who is to say? It would seem that if change is to be properly implemented in the middle school setting, all these points of emphasis must be attacked simultaneously.

The type of program ideally suited to the middle school is much easier to write about than implement. At the present time, middle school science is often an unstructured potpourri of methods, content, and approach, which frequently lacks vertical as well as horizontal coordination. It varies drastically from school to school and, sometimes, within a single school.

The chapter, "Developing Programs in Middle School Science" focuses on one program, The Human Sciences Program, as an example of what a good middle school science program might include. That this program attempts to cover all the bases is obvious. It considered "the physical, cognitive, social, and psychological characteristics of 10 to 12 years olds." Further, in setting up their program design, the curriculum considered the "characteristics of the learner, major societal trends, teachers and schooling, and the natural and social science disciplines." The author of that chapter offers no evidence of the program's success except to say that it is being used in a number of schools and that it has been tested extensively. Certainly, the evidence must have been collected and the program designers made aware of the program's strengths and weaknesses. The important point, however, is not the success or failure of the Human Sciences Program, but rather that it is a start; a first step--a foundation on which to build.

The Human Sciences Program, perhaps because of its subject matter, seems heavily weighted with humanistic and values education activities. Humanism and values have been accentuated in today's educational marketplace, and, although important, a caution should be taken to ensure that they do not dominate the program to the exclusion of other aspects of the learning process in the middle school science classroom. Humanism and values should be an everyday part of an adolescent's education, both in and out of the school. The fact that content is a vehicle to teach humanism and values does not mean that content is unimportant.

It is unfortunate that other examples of model programs (good, or not so good) were not identified for purposes of comparison. Undoubtedly the Human Sciences Program has been evolving and will continue to evolve, and as the times and people's expectations of schools change, it too will change. Having long been part of a conservative educational background, and a considerable believer in same, this author finds it difficult to accept all the directions that the Human Sciences Program seems to try to lead toward.

Specifically, it refers to two levels: "Self-directed learning"...and "Teacher as facilitator." The developers of the Human Sciences Program have created a program in which students are given opportunities for developing decision-making skills and self-direction within a structured situation, and this can be good. Teacher as facilitator is usually associated with an individualized approach. The individualized approach is often thought to be an ideal situation. The students select their own materials, work at a pace suited to their own abilities, and are able to explore areas of their interest. Generally, they are provided with numerous opportunities and experiences to grow and develop both mentally and socially, taking into account all of their needs. In that type of program, the teacher is able to meet with students in small groups or even individually.

However, in reality, it does not always work that way. Educators must never lose sight of the fact that these middle school students are still young adolescents, and that they are limited by lack of previous experiences in making judgments. Some educators are quick to point out that an individualized program provides them the opportunity to gain experiences and make judgments in a controlled environment; this is, of course, true. But, once again, it must also be stated that they are still young adolescents and don't always want to be making decisions and judgments. Far too often students get lost in the structure of the program. To them, it becomes one massive obstacle of confusion that they grow to hate. The student who yearns for structure feels cast adrift and is often very frustrated working in a self-directed program.

The comments contained here are not directed solely at the Human Sciences Program, but rather at the concept of self-direction by the students. There are many programs similarly structured in the schools today. These comments are intended as a reminder that young people often like structure, that they cannot always cope with an individualized approach. There are those persons who believe that an individualized approach is particularly attractive to gifted students, and this author is among them. Experience has shown, though, that no matter what the range of abilities involved in an individualized program, there are those pupils who will succeed and those who will not.

We must also remember teacher needs. The teacher energies required in an individualized program are exhausting. Initially, when a self-directed program is started in a classroom, the teacher is very excited and works at a level exceeding normal expectations. The work is well-directed, meaningful, and executed with tremendous amounts of enthusiasm. The Hawthorne Effect is operating to capacity.

But, within a year or two, teachers begin to wear down and tire from the pace demanded of those heading up an individualized program. The teachers begin to realize that they are really not being efficient with their time; e.g., they find themselves repeating the same thing over and over and over again to small groups or individuals. Further, the students all seem to need assistance at the same place and time in each lesson, even after many revisions in the lessons. The teacher begins to short-cut the process of self-direction by explaining to entire classes certain aspects of many lessons. Slowly, over a period of time, the program becomes less individualized and more structured. Perhaps this is as it should be in the natural evolution of any program.

There is ample evidence available to document the value of a self-directed or individualized approach for students, but teachers can not, nor will they, sustain the energy-debilitating pace that this type of program demands. The point being made is that the individualized program design must be a compromise of all its elements--students, teachers, content, materials, surroundings--and should be completely self-directed. It is necessary to bring into play many teacher-initiated class activities.

Once the necessity of a new program has been decided, it is hoped that the teacher in the school where the program is to be implemented will be involved in the decision as to the program to be selected. Ideally, the teacher(s) will initiate the change themselves, but, unfortunately, that is not always the case. If the new program is to have any chance of success, however, teachers must be involved in the selection process and in a meaningful way. It is insufficient teacher involvement to say that once a program is selected, the teachers will be trained in how to use the program and need not worry until that time. This is not involvement. No matter how great the program, from that point on, there is little chance of success.

Teaching is an extension of one's own personality; therefore, the teacher is a key element in the selection of any new middle school program. If the program and the teacher's personality do not mesh, the chances for that program succeeding, no matter how good the program may be, are minimal at best. Most teachers are able to identify programs with which they feel comfortable. In these days of assessment and competency testing, attempts are made to have everyone in a school system at a particular grade level teach identical programs with identical materials, and all at the same time. Although appearing to be a safe middle-of-the-road approach to the public, it certainly does not take into account the unique differences of either the teachers or the students. This is of great importance at the middle school level where teacher-student interaction is so important.

One other aspect of the Human Sciences Program that concerned this writer was the removal of the textbook as one of the primary student materials. There are many who speak with contempt about textbooks, but textbooks have their value. There is not doubt that the multi-text, multi-media approach is valuable, however, students require the crutch that a textbook provides, particularly when the teacher is unavailable. The criticism of textbooks is that they become the course of study. This is certainly true at times. As a matter of fact, in some cases, if there were no textbook, there would be no course of study. The same may be said for a program that doesn't feature a textbook as one of its primary resources. The other resources become the crutch, but they are usually not as readily available as is a textbook. Thus, the opportunities for frustration in programs without a textbook are greater than in one in which there is a textbook.

One final comment should be made on programs in the middle school. Packaged programs, in addition to sometimes meeting teacher resistance, are not usually cheap, either initially or to maintain. In times of a depressed economy, they are hard to purchase and keep fully supplied.

Reading about the three teacher education programs presented in this yearbook certainly suggests that there is more than one way to properly prepare teachers for the classroom. This, of course, assumes that all three of these programs of teacher preparation are successful--an assumption which seems reasonable to accept. The issue is not which is the best of the three methods of teacher preparation. Rather, the issues are what characterizes a good teacher preparation program and are teachers being properly prepared to teach in our nation's middle school science classrooms?

Recently, the educational establishment has been receiving its lumps on this issue. Frankly, youngsters couldn't care less about the program that prepared the teacher in front of them. All they ask is that competent teachers having all the appropriate characteristics direct their learning experiences. They want to be taught by good teachers. When they come to school at the beginning of a year, who their teachers are is of primary concern to them, just as it should be of primary concern to the institutions and the people responsible for their preparation.

There is a tremendous responsibility attached to preparing and training a teacher for a middle school science classroom. Science teachers, for example, have the added responsibility of chemicals, acids, and other materials in the classroom which affect the safety of the student. Teachers, in order to prepare students to handle the complex technical society into which they are entering, should be better prepared than ever before. The stresses and burdens placed on teachers today are greater than ever before.

No matter what the thrust, education ultimately comes down to the student and the teacher. Since little can be done to change the student, the emphasis on change must be placed on the teachers--producing quality teachers, and where necessary re-educating experienced teachers. Next to the student, the teacher is the most important factor in any educational program and should have the best preparation possible. One route to better education lies with better prepared teachers. The methods used to prepare teachers for middle school science classrooms will undoubtedly vary, but the end product must be a competent teacher, prepared to handle the unique characteristics of the middle school adolescent in today's complex society.

Today, many educators are involved in research. This, by itself, is not dangerous as long as the primary responsibility of the institution is still teacher preparation. Those responsible for teacher preparation programs must constantly ask themselves if their program is doing a creditable job of producing quality teachers. It is hoped that they are not allowing everyone who enters their program to simply pass through and become teachers. If they are, their program is a sham.

Everyone is not, and will never be, qualified to teach. This is not to assess blame for teachers who have failed, but rather to emphasize that some people are just not cut out to be, and should not be, teachers. It would seem to this author that preventing unqualified people from entering the teaching profession would speak to the success of any preservice program. There are already far too many examples of those unqualified to teach who are presently teaching in our nation's schools. These "teachers" have become an obstacle to those trying to improve education in the local school setting. Granted, the local schools also must share the blame for unqualified teachers who are presently teaching. Obviously, once the newly prepared teacher has acquired a teaching position, the control of that teacher shifts from the college or university to the local school district.

It is on this point of shifting control that this writer takes issue with all of the plans as stated in this publication. There must be follow-up before final certification and full teaching credentials are awarded to any teacher. There must be a time when both the certifying institution and the employing institution have dual responsibility over this candidate for the teaching certificate; an internship of sorts.

At the middle school level, the internship year would be of particular value. There would then be a structure to merge and unify theory and practice in a cooperative venture to produce a more competent teacher and improve the total educational picture at the middle school level. The internship would be able to focus attention on all the unique aspects of science education at this level.

The type of internship could vary from school to school. It would be a form of advanced student teaching except that the teacher would be fully paid, and completely responsible for the events that occur in that classroom. A major difference over present programs is that someone in the certifying institution would be required to assess this teacher's performance, as would someone at the school in which the teacher worked. Visitations would be required often by both the local and institutional representatives. Course credit might or may not be given. Permanent certification would not be issued until both the local and institutional representatives were fully satisfied that the potential teacher was qualified.

This internship should not be looked upon as just another course. This teacher's position would be on the line, and improvement would be expected throughout the year. It is time that the profession began to police itself. Every educator who evaluates the performance of a potential teacher should ask himself/herself if he would want his/her children to have the teacher that he/she is qualifying as certified. Many would suggest that experienced teachers should be subjected to the same type of criteria.

With this type of program, the teacher training process would also complete itself more naturally, and our children would be the principal beneficiaries. It would be particularly effective in places like Georgia where people get certified and then teach out of their primary content area. All teachers, of course, do not belong in front of middle school students. Certain personalities find a home at this level while others are miserable at this level. The internship program at the middle school level would be particularly effective in identifying these teachers.

Overall, the eight goals stated in the Georgia Plan appear to be taking young preservice teachers-to-be in the appropriate direction, although, as the authors indicate, they have a distance yet to travel. Obviously, these goals could be similarly applied to any discipline in addition to science.

One particularly disturbing element noted is the ability for so many teachers to end up teaching out of their major certification area. This is a strong weakness of certification standards. This author is not familiar with certification procedures in all states, but he hopes that this is not the normal situation, though he fears the worst.

Of particular interest in the UPSTEP Program at the University of Iowa is the way potential teachers are involved at an early stage in their education. If indeed Iowa is getting people potentially interested in becoming teachers before they know it themselves, the program is certainly unique. It will take a large effort to weed out those unqualified to teach science in the middle school, while, at the same time, zeroing in on those destined to become outstanding teachers.

A fear of this author is that the program may show superficial interest. If they are sharp, they may be able to pass through the program even though they may be better off teaching at another level. They may get into a middle school science classroom and do irreparable harm. Unfortunately, the article did not offer more information relative to their certifying requirements and the follow-up procedures they had.

Like the Iowa UPSTEP Program, the Memphis State Plan does not explain its relationship to certification in that state. However, it too seems to lead to the successful development of teachers. The Memphis Plan stresses teaching first and curricula second, this is definitely a strong point of the program. There is absolutely no value in learning to teach one curriculum, only to find yourself in front of a class teaching an altogether different program. Some might argue that this is not the case, but the experiences of this author show that teachers thusly prepared have a very hard time starting out with a different curriculum. The Memphis Plan seems just one short step removed from an internship program.

The papers on in-service education presented by Beizenhurtz and Erb differ greatly in approach. Beizenhurtz offers a wide variety of approaches utilizing a number of resources. Erb on the other hand offers only one approach incorporating the university as the central support system, although appearing to create equality by placing it at one vertex of the triangle used to explain the operation of this plan.

In-service education is, to say the least, a very tricky operation. There are as many plans as there are schools. There is no one best system that can be bottled and shipped throughout the nation. The approach described by Erb is very similar to the internship plan proposed earlier in this paper. The triangular partnership described by Erb has merit in that the objectives and goals of all involved can be considered.

Because most teachers presently teaching in middle school science classrooms were not trained to teach at this level, the need for in-service training is self-evident. This does not imply that these teachers are incompetent. It does imply, however, that they may still have a great deal more to learn, but that the learning should be much more fruitful because it would be built on their experiences. The need for in-service education exists. The problem is to respond to this need. How can all those in-service middle school science teachers be made aware of the tremendous amounts of knowledge and information collected about the early adolescent that would make them better teachers, were they to have this information and knowledge?

It is often difficult to get experienced teachers, teachers who have already spent a great amount of their own time taking courses, back into the classroom as students. There are a number of factors which affect their resistance, but the two most dominant ones are time and money. Teachers don't want to give the time unless they get paid for it. A plan that incorporates in-service education into the school day has the greatest chance of meeting with their approval--in many cases, it is the only chance of obtaining their approval and participation.

Re-certification requirements are being discussed in some states? If this should become a reality, in-service programs of all kinds will flourish.

The publication of this yearbook is a milestone in middle school science education. For an organization such as AETS to devote an entire issue of its yearbook to science in the middle school can be called nothing less. A corner has been turned.

Whether the reasons for the turn have been philosophical or economical is really not important. What is important is that the foundation for greater growth in middle school science in our nation's schools has been formulated in this document. Although it does not take us into the future, it surely points the way.

Every middle school science teacher should read this yearbook. In this paper, it has been impossible to speak to the many good points brought out throughout the yearbook. They are there for the reading. Rather, the emphasis in this paper has been to focus in on some of the larger issues as seen from the point of view of the in-service science teacher. Much of what has been said could be applied to any discipline at any level of schooling. In the end, of course, it is the students who must benefit most from this work, which is what education is all about.

IMPROVING PRACTICES IN MIDDLE SCHOOL SCIENCE: REACTIONS FROM THE FIELD

REACTION III

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The middle school emerged as a necessary alternative to the junior high school, full of promise, new directions, and with curricular emphasis on the needs of the early and pre-adolescent child. Confusion, fragmentation, lack of direction, and lack of identity, however, have been characteristic descriptors of middle school education. Numerous terms have been used to describe and identify the middle school child, specific preparation for teachers at this level has been almost nonexistent, and curricular innovations of recent years have not been reflected in the programs of middle schools. It is heartening to observe a new and revitalized spirit emerging in classrooms of pre-adolescents across the country. Recent curriculum development efforts, teacher certification programs, new-found professional pride, and the realization of psychological and social factors affecting the educational achievement of the middle-grades student are rapidly changing the complexion of the "step child" of the American educational system.

Middle-school-age children are a complex combination of variables. They are exciting as well as exasperating, adults one minute, babies the next, independent and then completely dependent. But at all times, they are sampling their environment in an effort to emerge as adults. These complex and diverse characteristics require much more than a science content course if maximum development of the individual is to occur.

The Human Sciences Project described in this volume would appear to be a major effort at providing a science course which addresses more than the content concerns of textbook and curriculum efforts to date. The psychological, physical, and social, as well as the cognitive needs of the pre-adolescent, have been considered. Opportunities are also provided for developing decision-making and social interaction skills--self-awareness and peer awareness via a curriculum based upon the study of the human organism and the human enterprise. The modules require self- direction, have an instructional format allowing for small group interaction and individual investigation, and present science in a context of social and technological advances.

The teacher must assume the role of facilitator, and become less directive and a partner in the investigative process if this curriculum is to be properly implemented. This role is foreign to many science teachers, however, and may be a stumbling block in the success of the program. Other aspects of materials such as the Human Sciences Curriculum Project may be detrimental to their wide acceptance in the middle school. The modular approach may require restructuring of often rigid schedules, and the introduction of "controversial issues" will chill many educators. The activities related to daily life, even though they often have much appeal to the student, may be viewed by many educators and students as unscientific and not worthy of incorporation in the science curriculum. The interdisciplinary nature of the modules will also be difficult for many science educators to accept. It would seem, however, that all of these aspects of the program can be overcome by good teacher preparation and realignment of priorities and goals for middle school science instruction.

The recent development of materials for middle school science instruction, including the Human Sciences Program, has identified a number of researchable concerns and problems garding middle school science instruction. Many of the ggestions made were also identified by a recent joint NSTA/AETS middle school committee. They can be summarized as follows:

1. Studies need to be made that will coordinate the data base about early adolescents and science education for this age group.

2. Specific studies need to be carried out as to how the pre- and early adolescents best learn science.

3. There is a need for better dissemination of satisfactory science programs for middle-school-age students.

4. More and better quality in-service programs specifically designed for middle school teachers are needed.

5. The importance of science as "basic" and a part of general education for every student must be emphasized in curriculum development efforts.

6. Science curricula need to provide a better balance of pure and applied science at the middle school level.

7. More curriculum development efforts should be directed at the middle-school-age student.

8. Studies need to be conducted to determine effective instructional strategies and administrative arrangements for middle-school-age children.

9. Greater provision needs to be made for gifted students in science classrooms at the middle school level.[1]

These and many other topics need to be considered in future curriculum development efforts for the middle school science student. The Human Sciences Curriculum Project would appear to be a major step in the development of improved science instruction for the pre- and early adolescent student.

Preservice and In-service Teacher Education

Certification programs and standards for middle school educators have been a proverbial "educational football" since the development of the junior high school many years ago. Until recently, teaching the middle grades had little stature in the profession and was usually a stepping stone position until a "real" science teaching position at the high school level opened. Certification standards in most states have contributed to this identity problem. Elementary and secondary certificates generally overlap assuring enough teachers for the middle grades. The 1-8 and 7-12 certification procedure indicates to the profession, and the public, that any teacher can teach students in this transitional period. Nothing could be further from the truth. It is encouraging to see states moving toward specific certification standards and recognizing the special needs of the pre-adolescent student.

The Georgia Program offers a strong preparation in the sciences and science education, and in addition appears to recognize the needs of the middle school teacher in the areas of reading and special education. The need for breadth in the teacher education program is reflected in the "two-teaching fields" requirement. The overall strength of the program lies in the abundance of field-based experiences, the emphasis on reading instruction, and additional methods courses required in the "nonspeciality" areas.

The goals that have been identified for the education of science teachers which stress process development, teaching strategies, and the developmental needs of adolescents are reasonable and worthy. Teachers with a secondary certificate have generally opted for a traditional context/textbook-oriented program at the middle school level because they had not learned how to teach science processes in their teacher preparation program.

[1]Report to NSTA, July, 1980

Also, the psychological needs of the pre- and early adolescent have rarely been attended to in either elementary or secondary methods courses and only in a "survey sense" in the basic human growth and development courses offered at most institutions.

Science education programs of recent years have stressed the materials and programs stemming from the NSF Years and, although this knowledge is important, it is critical that prospective teachers be equipped with knowledge and the ability to adapt and supplement existing programs since so many schools utilize a limited laboratory/textbook approach to science teaching at the middle school level. As a consultant to school districts about the teaching of science, one is often confronted with one of two requests:

a) "Tell me the best textbook or program I can plug in and have a good science program."

b) "We are writing our own curriculum, please give us assistance."

Both of these requests stem from the desire to offer the best possible science program, but, in the first case, few texts or programs can be all things to all students, and, in the second case, one or more of three very important needs are missing: writing skill, content knowledge, and time. Ability to adapt materials to a specific school setting and to meet specific goals would appear to be a major objective for in-service and, perhaps also, many preservice programs.

Classroom management and instruction for students of varying abilities go hand-in-hand. Many discipline/management problems stem from a lack of meeting the needs of individual students. Management of a science classroom requires additional skills. Instruction in this area has been sorely lacking, particularly with respect to pre- and early adolescent students. As we become more professional and accountable in our approach to education, skills in diagnosing learning problems, assessing student achievement, and preparation of instruction will be needed.

The bottom line of the Georgia plan really summarizes a successful program: ". . .the program prepares individuals who <u>want</u> to become middle school teachers and who <u>want</u> to work with pre- and early adolescents."

The clinical field experience program described in the Iowa UPSTEP model also has many merits. Prospective middle school teachers have an opportunity to develop and field test instructional units and gain experience working with pre- and early adolescents under the supervision of both practitioners and college personnel. The emphasis on the developmental phase of these students is critical and is an area of weakness in many teacher preparation programs. The early entry emphasis is another strength since many middle school and secondary teacher candidates make this decision late (usually during the junior year) with little undergraduate time left to formulate a personal philosophy of education conducive to developing an appropriate instructional style.

The four-year sequence of the UPSTEP program stressing both science and the "communication process" provides much opportunity for exploring career and life goals as well as teacher preparation. The seminar approach utilizing visiting scientists would seem to have a double-edged return in student outcomes and in building a stronger relationship between scientists and science educators.

The methods seminars during the junior year would appear to provide many opportunities for students to develop their instructional skills. Video taping and critique sessions are excellent ways for students to analyze their teaching methods and skill in delivery. These sessions should, of course, be developed in a positive atmosphere and focus on improving instructional skill and not personality traits. For many teachers without these kinds of experiences, the first "on the job" feedback from the principal or supervisor can be damaging to his/her self-concept and relationship to the school administrator.

The Memphis State University Plan embraces a scholastic attitude toward science education which should be attractive to modern middle school educators. Examination of the different approaches existing in our schools, reflecting on one hand a traditional, content-oriented "junior high" approach contrasted with a middle school curriculum based on "needs of the adolescents," is necessary to adequately prepare professionals for the field.

Limiting the number of instructional strategies introduced in a preservice program is crucial, as most new teachers are overwhelmed with the complexities of the teaching-learning process and really need only a few well-developed strategies for efficient classroom management as they enter the profession. The program might be strengthened by having a greater articulation with science courses, more field-based clinical experiences, and by paying greater attention to adapting "modern curricular" materials to existing programs as well as to developing knowledge of new programs.

The teacher education programs described are strong programs with many common elements. The departures from traditional middle school/junior high teacher education programs include the emphasis on clinical experiences, early entry into the program, specific courses and/or seminars dealing with the psychological development of the pre- and early adolescent, the emphasis on science education contributing to the development the "whole child," and greater attention to complementary problems, such as reading instruction, which is needed at the middle school level.

The problems of preservice preparation for middle school teachers are certainly not unique to the three regions represented in this document. Increased attention to the needs of the preadolescent child and the complementary needs of the middle school teachers are being felt in classrooms across the country. As other universities develop stronger programs similar to these efforts, middle school students will be receiving the type of instruction needed for their total development.

The problems identified for in-service teachers, including the lack of state certification programs for middle school teachers, lack of preparation in science areas usually taught at the middle school level, lack of teacher interest in middle school education, poor attitudes toward in-service and self improvement, and the greater autonomy of teachers with relatively little supervision, have indeed created a difficult, but not insurmountable, in-service education task. The lack of supervisory personnel poses a real problem for in-service education for many schools. Science teachers, however, can take initiative and solicit help from their state science coordinator or from college science educators in an attempt to improve instruction.

The major inadequacy of in-service programs can rightfully be blamed on "all-district" blanket approaches which have not considered the needs of the individual schools and teachers. The obvious need of "individualized" in-service programs suggests an in-house, staff approach which has proved successful in both improvement of instruction and developing staff relationships. In most school settings today, science teachers do not have time (or take time) to meet with other science teachers and discuss programs, reflect on successes and failures, and assess student progress as an outcome of the established curriculum. This may very well reflect the attitude that in-service training is something done to us by someone outside the school. We must make better use of the talent already existing in the school by providing time for productive thinking and dialogue through which our programs can be refined. Outside consultant help can certainly be beneficial. However, it must be solicited for a specific need and selected carefully to deliver pertinent information. The "one-day-stand approach" has probably destroyed any warm feelings most teachers have for in-service education.

Successful in-service education programs can be developed if the following are considered:

1. Greater teacher involvement in planning and delivery is essential.

2. Rarely will "all-district" sessions meet the needs of individual schools and teachers.

3. In-service programs must be based on individual program needs and tailored for a specific school program.

4. Congruency must be maintained between program goals and in-service education.

5. Building principals working with supervisory personnel must take a greater interest in and provide more leadership for in-service education in their schools.

Improvement of middle school science instruction hinges on the development of all three areas discussed in this section of the yearbook. Excellent curriculum materials rapidly become mediocre in the hands of poorly trained teachers. On the other hand, excellently prepared teachers are often hamstrung with curriculum constraints and poor materials and facilities. The importance of science in the curriculum must be emphasized in programs in which the cognitive, psychological, and physical development of pre- and early adolescents is considered. Improved curriculum development efforts and preservice and in-service teacher education programs will contribute to this end.