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SCIENCE CURRICULUM CHANGE AS IT OCCURRED IN A SMALL RURAL COMMUNITY: A CASE STUDY

by

William J. Pollard

A Dissertation Submitted to the Faculty of The Graduate College in partial fulfillment of the Degree of Doctor of Education

Western Michigan University Kalamazoo, Michigan August 1977
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CHAPTER I

STATEMENT OF THE PROBLEM

The purpose of this case study was to investigate the process used by a small rural school system in the development and implementation of a curriculum change. As a case study, an attempt was made to identify in detail the methods used by a science study committee in determining the needs of a science curriculum, plus the means utilized to meet those needs and methods for evaluating how well the science curriculum objectives were being met. A case study was believed to be the logical research method for this study since the subject involved the examination and outcome of human behavior. The value, if there is any, of this small school system's experience in curriculum development for other similar schools seemed to be that it provides opportunity for close scrutiny and analysis of the processes of curriculum change and consequent potential for avoiding whatever weakness and shortcomings of this particular experience uncovers. Basic questions for which answers were sought by this research study were:

1. Why was there a need for a science curriculum study in the school system, and of what importance could such a study be to other districts?

2. What historical data support the idea that curriculum change in science is an ongoing process and that the present study is a part of that process?
3. What did the science committee do? Why? And how?

4. What were the changes as a result of their study?

5. What were the results of an evaluation of the curriculum changes one year after the study was completed?

To answer the above five questions, the research has been divided into four chapters. The first chapter discusses question 1. Chapter II answers question 2, while Chapter III addresses questions 3 and 4. Question 5 is the focus of the last chapter.

Need for a Science Study Committee

The need became evident for a science study committee after a series of citizen- and teacher-initiated pressures moved the board of education to examine curriculum effectiveness or appropriateness. A citizens' committee had been appointed by the board to investigate the needs of the schools as they related to a new building program. This committee of local citizens had also been directed to consider curriculum changes that might take place as the result of the building program.

The result of the citizens' study was a highly critical report submitted to the board of education. This report included criticisms about the lack of a written curriculum for the schools, and cited low test scores on standardized achievement tests in the middle school. The report placed
considerable pressure on the board of education in the form of oral criticism and requested curriculum changes. Demand for action, by the board, resulted in the resignation of the high-school and middle-school principals, and the contract of the superintendent was continued on an annual basis without a pay raise.

Further, it was requested by the citizens' committee that teaching guides be developed and used by the teachers. Guides were to reflect educational goals of the community as viewed by the citizens' committee as well as relevant learning and instructional objectives as indicated or implied by the current testing program. Sample curriculum guides from other schools were also to be reviewed and considered for their contribution towards resolving the problems in the local system. Therefore, it became important not only to meet the locally perceived needs, but to incorporate, wherever possible and applicable, the goals of the Michigan State Department of Education and national goals as stated by the national assessment tests. The committee presented to the board of education samples of the curriculum guides of other districts as examples of the kinds of materials they thought desirable for their own school offerings.

In addition to the pressures for curricular evaluation change from the citizens' committee, demands for curriculum revision were coming from the teachers in the form of a proposal to establish a curriculum council, which was to be
partially funded by the local teachers' association. This proposal emerged during contract negotiations with the board. Members of the teaching staff also had participated in the development of the initial report of the citizens' committee. Subsequently, teachers had negotiated a curriculum council, into their contract, which was to consist of teachers and administrators. The teachers' association contributed funds for its operation.

Because of the actions of the community, low middle-school student achievement scores in science, and demands by teachers and administrators, the board of education were obligated to form a science study committee. The catalyst, in this school and other small rural schools, was accountability in public education; thus, the significance of this case study to other districts.

Importance of the Study

The school under study appeared to be typical of many small rural communities. According to Winters (1975), "Small schools serve 38.5 percent of the United States school age population" (p. 3). These small districts have many common problems, such as serving relatively large geographic areas while having low tax bases and, consequently, limited economic resources. The school system in this study, with 120 square miles in two counties, shared this common geographic difficulty with the other school districts in the State of
Michigan. This system ranked 407 in the 530 Michigan school districts in terms of dollars spent per child. Limited resources and the large service area provided common characteristics of most of these smaller school districts.

The need for curriculum change had been recognized by the citizens' committee. This same need of a comprehensive curriculum change in science programs had been recognized by the United States Office of Education as evidenced in the establishment of grants to support experimental schools projects. These federal grants were designed to test the hypothesis that significant and lasting improvement in education was more likely to occur when there was comprehensive or wide-scale total system change at the local level.

The idea of curriculum change for small schools was not a new one, but the pressure for change had increased as public education became more involved with accountability. A demand for all schools to produce commonly agreed-upon goals increased. Larger school districts established offices of curriculum research and development, and full-time personnel were employed to work with the teaching staff in writing curriculum and course goals and objectives. Resources which were necessary to implement this kind of evaluation and revision often included federal funds and personnel to write proposals for acquiring those funds. Small school systems, with their limited number of employees and other resources, were often not able to develop funding proposals and, in
general, failed to receive monies from the federal government to effect large-scale curricular revision. According to Archer (1968) and Bost (1969), smaller school systems occasionally joined into larger groups, such as intermediate school districts, in order to gain funding from the United States Department of Education.

The school system involved in this study was one such district. The realization that the process of change was expensive resulted in a reluctance by the school system to become involved in curriculum studies. However, the pressure for change could not be ignored. As the people in this district demanded change, so did people in other districts, and it is believed by this writer that demands for such curricular changes will continue in the future.

The methods used by large districts seemed financially out of reach for small systems. Gillespie (1973), an intermediate district curriculum director, tried to offer an alternative for the small district. His work related to the development of an English curriculum on a county-wide basis. There were seven school districts involved. Gillespie formed a group comprised of one member from each district to work as a committee to develop a county curriculum. Early in his project, the basic goal was changed from developing a county curriculum to the construction of a resource guide for English teachers. Thus, the final result was not an English curriculum as proposed initially, but a resolution
to continue to work with the local districts to meet individual school system problems. At least part of the failure of Gillespie's project to meet expectations was attributed to lack of financial and moral support by the administration in the various districts involved. School administrators were either unable or unwilling to give the type of support needed for the successful implementation of such a joint, cooperative project. Although the administrators recognized the need for change, the project failed to establish even standardized goals for the county.

The inability of the schools to agree on common goals meant that each system would have to develop their own goals for an English program. This problem of developing and agreeing on goals is not new and will be discussed more fully in Chapter II in the historical development of science curricula. In the past, problems of developing programs had been solved by adopting a text, and then the series became the school system's goals.

Problems related to this type of adoption were discussed by Lehman (1971) and others who have noted that standardized programs written by commercial publishing houses rarely met the objectives of specific school programs. Yet a small school system, faced with increased pressure for accountability, had to find the means to improve their local programs to meet the demands of parents and teachers to measure achievement, as happened to the case-study board of education.
This study examined the processes of curriculum change in a small school system from its inception to its conclusion. The specific program investigated by this study was the science curriculum, since this was the area in which the school system elected to make such changes.

As mentioned above, pressure for curriculum change came from three distinct sources: (1) the citizens' committee by way of the citizens' report, (2) teachers by way of their negotiated contract, and (3) low student scores in the middle school on standardized tests. The concerns generated by these sources stimulated the board of education to appoint a science study committee. It was the work of the committee that provided the focus for this study.

Processes of curriculum change took place in two phases: (1) the formation of the science study committee, and (2) committee development of the science curriculum guide. The major focus of this study was the work of the science study committee and the methods, processes, and means used to initiate curriculum change and the results of the activities of this committee.

Assumptions

Before the committee was formed and work began, the following assumptions were made: first, that small rural school districts do need to develop the methods and means for instituting curricular changes which are within the
budgets and resources of those districts. In view of the fact that there are only limited numbers of studies dealing with curriculum change in small districts, there seemed to be a need for a study of the actual processes involved in curriculum change in a small school system. Second, it was possible for small schools with limited funds and resources to develop methods and to implement their own curriculum changes which could satisfy assumed needs. Finally, it seemed reasonable to assume that whatever weaknesses found in the curriculum changes attempted by the school district studied could be traced to the processes used in the development of that curriculum rather than the lack of funds.

Definition of Terms

In order to achieve better understanding, the following terms used in the case study are defined:

Curriculum.—In the present study, curriculum will refer to all the experiences which are offered to learners under the auspices or direction of the school.

Curriculum improvement.—According to Doll (1970, p. 21), curriculum improvement, broadly defined, is more than alteration or rearrangement of pupil experiences into a simple, preconceived plan; it involves the reeducation of teachers through individualized in-service education and constructive supervision.
Development.—Development is the production, implementation, testing, and evaluation of curriculum activities, methodology, materials, and organizational plans for accomplishing the improving educational goals and objectives as an application of evaluation and research.

Goal.—Tyler (1967) stated that a goal is a broad or general long-range intangible principle.

Means.—As defined by Webster (1967), means are the processes and procedures used to achieve a desired outcome.

Method.—Method is "a procedure or process for obtaining an object" (Webster, 1967, p. 533).

Process.—According to Webster (1967), process is "a series of actions or operations conducing to an end" (p. 678).

Objective.—An objective is a preplanned, specific activity with a specified learning outcome (Waddimba, 1975).

Implementation.—Implementation is the process of operationalizing the goals and objectives of a plan.

Junior high school.—In the present study, a junior high school is a school consisting of grades 7, 8, and 9.

Middle school.—In the present study, a middle school consists of grades 6, 7, and 8.

Before the work actually began on the case study, the above working definitions were used by the science study committee and this writer.

For the purpose of review, the summary follows.
The purpose of this case study was to investigate the processes, method, and means used by a small rural school system in the development and implementation of a curriculum in science and to evaluate the results. This first chapter established the fact that several definable groups were exerting pressure on the school system's board of education to institute changes in school curriculum. Chapter I also identified several economic, social, and geographic characteristics shared by small school systems. Included in the chapter were the basic assumptions of the study and the definitions of terms used.

Chapters II and III will describe attempts to answer the following questions: Chapter II—What historical research supports the idea that curriculum change in science is an ongoing process? and Chapter III—What did the science study committee do, and why? Chapter IV will provide the results of the study, the status of science instruction one year after implementation, a summary, and recommendations for future curriculum investigations in small school districts.
CHAPTER II

BACKGROUND AND RELATED RESEARCH

This chapter examines the historical background of the curriculum development and builds on evidence which suggests that small schools are very numerous. There is a need for a means by which small districts can achieve systematic, comprehensive, and effective curriculum changes in spite of their limited funds and resources. This chapter has been divided into two sections. The first section provides historical review of science education, and the second portion reveals the case-study school's background.

Historical Review of Science Education

According to Hurd (1967), science has been a part of public elementary education in the United States for most of its history, yet emphasis on science depended more or less on the interest and knowledgeability of the teacher of the subject, rather than on a formally prescribed curriculum. In the 1700's, the practical sciences developing at the university level were physics, earth science, and astronomy, as found by Lee (1967). A short history of trends in elementary science reveals that science from 1700 to 1850 consisted of learning the names of rocks, plants, animals, constellations, and clouds. The major educational goal was to have children
acquire "interesting information."

From 1850 to 1890, the emphasis changed, and science was taught with a religious orientation and for the purpose of moral development. According to Hurd (1967), the major goal for science was to develop "moral values" (p. 2); it was not until the American Civil War that laboratory experiments became a part of science instruction. Hurd stated that as late 1890-1900, the primary reason for teaching science was to "strengthen the mind" (p. 2). Problems of increasing difficulty were presented to students to help increase thinking capacity. Through improving the mind in one science, the learner presumably increased his or her capacity in all areas of learning (Lee, 1967).

By the end of the nineteenth century, science was well established in the American high school as part of the general educational program. The American frontier was rapidly closing, and the growth of industry had begun. Hurd (1967) stated that "the earlier purpose of training the mind was replaced by the natural science movement" (p. 1). This era was brought about in part by a fear that urbanization and industrialization would destroy nature. It was during this period that science as we know it began, in part by scientific research and discoveries as noted by Hurd:

Einstein's ideas about the matter-energy relationship created a stir in physics; Mendel's laws were rediscovered and the biological sciences gained a new enthusiasm. The discovery of a way to control malaria and yellow fever provided a new impetus to
medical research. Rutherford and Mosely added new ideas to the field of chemistry. The work of the Curies at this time is well known, and other great names could be added to the list—Planck, Morgan, van't Hoff, Koch, and Devries, for example. (p. 2)

Science education became less formal with the advent of the "junior" high school. In 1927, an effort was made to provide a more general background in science. Hurd (1967) credited Gerald Craig, then a doctoral student at Teachers College, Columbia University, with a new concept of science teaching for children. In his program, children had an opportunity to learn about airplanes, automobiles, and trains through a study of transportation. The unit on communication included such inventions as the telegraph, telephone, and radio. Throughout the entire course of study, the primary goal might be described as science for social utility. (p. 2)

Science instruction during the pre-World War II period emphasized applying learning to everyday situations. This was supported by Lee (1967) when he stated that "the pattern was influenced by the Progressive Education Movement and its search for individual self-adjustment" (p. 2). According to Lee, some historians claim that science teaching came of age during World War II. This is probably true in a limited sense. Certainly science and technology influenced the duration, if not the outcome, of the armed conflict. After nuclear energy was used as a weapon, strategies in the struggle for world power took on new dimensions. Today, the power a nation yields is largely determined by its state of advancement in science and technology. In this country,
both government and private agencies realize the importance of maintaining sufficient manpower to insure our present level of scientific leadership. Both have channeled large sums of money and talent into their efforts to upgrade all aspects of the scientific enterprise. These efforts were heightened in 1957 after the Russians launched Sputnik I.

With the beginning of the atomic age, governments and private industry started placing more emphasis on science education as it related to national defense needs. Educators began to look at how the science curriculum had been developed and at the major emphasis of science programs.

According to Merrill (1971), science curriculum development had three stages up to that time. Stage I, the "fact-gathering" stage, he identified as where "the teacher and text were the major sources of information" (p. 39). If used as the basic teaching resource, texts—often the products of several authors or experts in the field—determined what would be taught in the science curriculum. This text-centered method of developing curriculum placed course material in a progressive, cumulative order from simple to complex and concrete to abstract. The Stage I method of adopting and implementing new program materials included the following steps: (1) a small group of teachers reviewed books; (2) they reported results to the board of education, along with a ranking of the books' utility for the students; and (3) the chosen program recommended by the group was adopted by the
board. There was included in this system a review of, and reaction to, the current program by teachers in either a written or oral form. The text, in effect, became the curriculum for the school. This procedure was effective in achieving consistency in that whole districts followed the curriculum as reflected in the text. It did not, however, allow for individual differences in the life styles of students or of community demographic and economic differences as they related to the school. Factors such as the socio-economic conditions, environment of the school system, or local resources were not considered as the curriculum was developed. The programs were teacher- and text-oriented, and experiments, if included, were generally of a simple nature. School library materials were often used as the primary source of information, whereby the students read books and wrote reports on what they had read.

This fact-gathering approach was brought to an end by the launching of Sputnik. The National Defense Act of 1959 provided the funds for what may be described as the second stage of curriculum development. Stage II included the major curriculum projects of the 1960's and may be termed the "structure process" stage (Merrill, 1971, p. 39). The curriculum projects, according to Fowler (1973), had many common characteristics including outside funding, university input, secondary teachers' involvement, conferences to write materials, and pilot studies. As found by Merrill (1971),
results of this approach were curriculum studies such as the Biological Science Curriculum Study, the Minnesota Mathematics and Science Teaching Project (Minnemast), and the Science Curriculum Improvement Study (SCIS).

The structure process, as in Stage I, was directed toward class instruction, and information-giving was still a major focus and objective of the curriculum. Stage II programs differed from Stage I in that teachers became involved in the development of the text and laboratory materials. This teacher involvement, according to Merrill (1971), allowed for more local input than did the Stage I approach.

Paparello (1966) used the science institute and a Stage II approach to train teachers and, at the same time, involve them in the development of both text and laboratory materials but found that the teachers, returning to the local districts after the institute experience, were unable to transmit their enthusiasm to their colleagues. This finding was supported by Kalra (1973), when she found that the teachers resisted radical changes, and curriculum changes based on institute experiences frequently proved more expensive than local schools could support. During the 1960's, the use of such conferences became widespread, as Wolfe (1970) found:

The National Science Foundation supported sixty-six projects according to its 1966 report entitled "Course and Curriculum Improvement Projects." Of this number, five were general projects; fifteen were of the multi-disciplinary approach for
elementary and secondary schools; eight were
directed towards astronomy, atmospheric and
earth sciences; eight concentrated on biology;
four stressed chemistry; twenty developed inno-
vations in mathematics; and five were addressed
to physics (including engineering). (p. 71)

Although there were different subject area programs,
their developers followed a sequence of activities which
Fowler (1973) recorded:

1. Funding was obtained from an outside agency,
which very frequently was the National Sci-
ence Foundation.

2. University and/or college scientists were
the prime movers of the projects.

3. Secondary school science teachers were
listed as co-workers.

4. Writing conferences were scheduled and cur-
riculum materials were produced by teams of
college-level scientists and high school
science teachers.

5. Curriculum trials (pilot projects) were
scheduled in cooperating secondary school
science classrooms. Feedback from one or
repeated trials was used in making revisions
of the new materials.

6. Secondary school science teacher summer
and/or academic year institutes were pre-
pared by colleges and universities to pre-
pare high school science teachers to teach
the new programs.

7. Supplementary materials including such
things as apparatus, films, laboratory
guides, models, and teachers' guides were
prepared. (p. 268)

The Massachusetts Advisory Council on Education studied
the National Science Foundation's materials which were in
use in that state (Whitla & Punc, 1973). These materials
included the SCIS, the Elementary Science Study (ESS), and the Minnemast for grades K-3. Results of the study indicated that the National Science Foundation programs were oriented toward reading and that lack of reading skills prevented many students from using the materials. Thus, success of the programs was limited by the reading level of students and/or the reading level at which the materials were written. Another finding of the study by the Massachusetts Advisory Council on Education (Whitla & Punck, 1973) was that most elementary teachers had little training in the science areas and were reluctant to use texts that provided questions and experiments with open-ended questions.

Specialized or expert personnel proved to be an essential element of the teacher training aspect of implementation of Stage II, or structured process programs. However, according to Bost (1969), small school systems have rarely been able to afford such personnel. The operational science programs in small systems often consisted of what had been passed on by word of mouth or what had been found in old lesson plans. While larger school systems were employing curriculum directors and developing pilot studies, small systems with limited resources were endeavoring to join together to develop larger or county-wide structures.

By the early 1970's, Michigan State Department of Education task-force committees were set up to establish objectives in science. This movement to develop common goals in
education created pressure for rural school districts to develop guides for teachers to implement a curriculum which was related simultaneously to national, state, and local goals. Earlier, the report of a project by the National Assessment of Educational Progress (1969) indicated that in 1965, a group of science objectives had been developed for children of ages 9, 13, and 17, as well as for adults. The project was unique in that it included objectives both for people attending school and those who no longer attended school. Objectives were written in such a manner that at least one-half of all people in each age group could be expected to attain the recommended levels. This early project was later followed by "Minimal Performance Objectives for Science Education in Michigan" (Michigan Department of Education, 1974). Merrill (1971) found that the Michigan project, like others, resulted in the process of developing goals and objectives and led to Stage III of science curriculum development.

Stage III may be described as having several distinct characteristics, including the translation of goals into precise objectives cooperatively formulated by teachers and students. An increased sensitivity to the attitudes of students and individualization of objectives, content and teaching method, and evaluation techniques was also characteristic of Stage III. Problems of a more interdisciplinary nature and a wider variety of instructional methods and
equipment were developed that were not characteristic of either Stage I or Stage II. Stage III was concerned with the students' attitudes about learning, in addition to the subject information given. According to Merrill (1971):

The teacher in Stage III will devote much less time and effort to the conduct of whole-class instruction, particularly as an information giver. He will be spending much more time with individuals and small groups in formulating objectives, diagnosing learning needs, reviewing and selecting instructional materials and media, creating situations which demand active learning on the part of the students, evaluating learning outcomes, helping students evaluate their own achievement, and evaluating the teaching-learning process, especially as it relates to his own role and the maintenance of his professional competence. In other words, the teacher will be much more concerned with creating the conditions for learning and evaluating the outcomes, so that he knows what new conditions to create, and will be much less concerned with "teaching the students what they are supposed to learn." (p. 39)

It would seem, from Merrill's work, that the three stages of science curriculum development can be defined as the structural process, institutional curriculum studies, and translation of goals into specific objectives. The results have provided the bases for future studies.

Small school districts had tried to use the methods of each stage and had not yet developed a comprehensive method for curriculum change. In order to understand how these developments related to a local school system, it was believed necessary to include a background of the local district under study.

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Background of the School System Studied

History of the district

In 1939, the present school district contained at least 14 1-room schools. Thereafter, the area's 1-room school systems began to consolidate and, by the early 1950's, 3 K-8 districts and 1 K-12 school system existed. In the early 1960's, 3 of the K-8 districts joined together into 1 school system covering the northern half of the current school system. In 1969, under pressure from the State of Michigan, the present school system was formed into 1 K-12 district. The new school district contained 120 square miles and extended into 2 counties.

The school system reported in the present study was small, as defined by Drier (1975), as are 38.6 percent of the districts in the United States. It also met the criteria established by Archer (1968) as a rural school and shared the organization and finance problems common to rural schools.

Enrollment

At the time of this study (1973), 1,449 students were enrolled in the K-12 program, according to the fourth Friday child accounting forms submitted to the State of Michigan. The school system was divided into three levels: elementary, middle, and high school. Student populations as recorded in the board of education minutes of September 28, 1973, are shown in Table 1.
### Table 1

**Enrollment of Case Study District in 1973**

<table>
<thead>
<tr>
<th>Building</th>
<th>Student Population</th>
<th>Grade Levels Housed</th>
<th>Number of Classrooms</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Elementary</td>
<td>53</td>
<td>2-3</td>
<td>2</td>
</tr>
<tr>
<td>(2) Elementary</td>
<td>69</td>
<td>1-4</td>
<td>4</td>
</tr>
<tr>
<td>(3) Elementary</td>
<td>143</td>
<td>K-1, 4-5, &amp; Special Ed</td>
<td>6</td>
</tr>
<tr>
<td>(4) Elementary</td>
<td>379</td>
<td>K-5</td>
<td>16</td>
</tr>
<tr>
<td>(5) Middle school</td>
<td>394</td>
<td>6-8, &amp; Special Ed</td>
<td>16</td>
</tr>
<tr>
<td>(6) High school</td>
<td>411</td>
<td>9-12</td>
<td>22</td>
</tr>
</tbody>
</table>

The elementary level consisted of 644 students in 4 buildings. A 2-room cement-block building located on 5 acres was the smallest school in the district. It housed second- and third-grade students and 2 staff members. A 4-classroom elementary building was the oldest building in the system, and was located on a 1-acre plot in a small town near the center of the district. This building housed students in grades 1, 2, 3, and 4, with a teacher for each grade. The third building, with 143 students, was located on 13 acres adjoining a town in the northern part of the district and included 6 classrooms and a multipurpose room. There were 2 kindergarten classes, a morning session and an afternoon session; classrooms for grades 1, 4, and 5; and a special education room for the mentally impaired. The largest
elementary building contained 379 students and was adjacent to the high school on 33 acres in the largest village in the district. It contained 2 sections of kindergarten and 2 fourth grades, with grades 1, 2, 3, and 5 each divided into 3 sections. An office for the principal (for the elementary levels) was in this building. The location of the 4 elementary buildings was such that there were over 20 miles between them, which indicated the rurality of the schools. As with other rural school districts (Bost, 1969), communication between school buildings was difficult. Elementary students in all buildings attended school from 9:30 a.m. to 3:30 p.m.

The middle-school building consisted of grades 6, 7, and 8, and special education students. It housed 394 students and 16 teachers. Middle-school classes met in the same building as the high school, which had 411 students and a staff of 22 teachers.

Due to the overcrowding resulting from the high school and the middle school sharing the same building, split sessions were instituted; high school students attended from 7:30 a.m. to 12:30 p.m., while students in the middle-school program attended from 12:30 p.m. to 5:30 p.m. At the time of the case study, the split session was in its third year of operation, with no planned program approved to change the situation.

The student body was 80 percent Caucasian, 18 percent black, and 2 percent Mexican-American. Approximately 190
children of migrant workers attended school from September to mid-November and returned in the spring for about 6 weeks.

Geographical information

The school district was located in 2 southwest Michigan counties and contained approximately 120 square miles with 3 small villages, according to the Office of the Intermediate School Superintendent. The school district was located approximately 25 miles from the nearest urban area. Land formation in the northwest and southeast sections consisted of rolling hills. Cutting through the middle of the district was a system of 14 small lakes and extensive swampland. Many of the homes with lake frontage were owned as summer homes by people who lived outside the school district during the school year.

Economic information

The only industry located in the village district was a plastics company, which employed 100 people when operating at full capacity. Work was by contract, with frequent layoffs. Many of the residents continued their traditional farming, which formed the largest occupation in the area. The major crops were blueberries, orchard fruits, and asparagus. These three crops, and the activities associated with them, provided employment for migrant workers and also supplied employment for many of the local residents. The
remaining people commuted to places of work outside the school district such as the 2 larger metropolitan areas which were approximately 25 miles away.

Local dollars spent per student in the county for the 1973-74 and 1974-75 school years, as presented by the Citizens' Advisory Committee Report (1974), are shown in Table 2.

Table 2
Local Dollars per Student in County Districts

<table>
<thead>
<tr>
<th>District a</th>
<th>1973-74</th>
<th>1974-75 (Budget)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>273</td>
<td>250</td>
</tr>
<tr>
<td>B (case study)</td>
<td>245</td>
<td>282</td>
</tr>
<tr>
<td>C</td>
<td>1,239</td>
<td>1,200</td>
</tr>
<tr>
<td>D</td>
<td>278</td>
<td>230</td>
</tr>
<tr>
<td>E</td>
<td>229</td>
<td>258</td>
</tr>
<tr>
<td>F</td>
<td>310</td>
<td>331</td>
</tr>
<tr>
<td>G</td>
<td>294</td>
<td>307</td>
</tr>
<tr>
<td>H</td>
<td>463</td>
<td>451</td>
</tr>
<tr>
<td>I</td>
<td>323</td>
<td>330</td>
</tr>
<tr>
<td>J</td>
<td>447</td>
<td>408</td>
</tr>
<tr>
<td>K</td>
<td>370</td>
<td>426</td>
</tr>
</tbody>
</table>

aLetters were substituted for district names for the purpose of maintaining district anonymity.

Of all districts represented, a comparatively high expenditure was shown per child for district C, where a nuclear power plant was part of the tax base. Other districts in the county were similar to the one under study in both size and geographic make-up. The school district...
involved in the case study spent more money per student than only one district, but less per student than the other nine in the 1973-74 school year.

State equalized valuation (SEV) and tax millage for the district in the case study, from 1967-68 to projected figures for 1974-75, are shown in Table 3 (Citizens' Advisory Committee Report, 1974).

Table 3
State Equalized Valuation (SEV) and Tax Millage

<table>
<thead>
<tr>
<th>Year</th>
<th>District SEVa</th>
<th>Millage Allocated</th>
<th>Millage Voted</th>
<th>Total Operational Expendituresa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1967-68</td>
<td>8,523</td>
<td>8.68</td>
<td>9.00</td>
<td>150.3</td>
</tr>
<tr>
<td>1968-69</td>
<td>10,310</td>
<td>8.68</td>
<td>9.00</td>
<td>182.3</td>
</tr>
<tr>
<td>1969-70</td>
<td>11,936</td>
<td>8.68</td>
<td>11.00</td>
<td>234.9</td>
</tr>
<tr>
<td>1970-71</td>
<td>12,501</td>
<td>8.68</td>
<td>13.00</td>
<td>271.0</td>
</tr>
<tr>
<td>1971-72</td>
<td>13,868</td>
<td>8.68</td>
<td>13.00</td>
<td>300.7</td>
</tr>
<tr>
<td>1972-73</td>
<td>14,936</td>
<td>8.68</td>
<td>13.00</td>
<td>323.8</td>
</tr>
<tr>
<td>1973-74</td>
<td>15,931</td>
<td>8.68</td>
<td>14.00</td>
<td>361.3</td>
</tr>
<tr>
<td>1974-75</td>
<td>18,740</td>
<td>8.68</td>
<td>16.50</td>
<td>461.9</td>
</tr>
</tbody>
</table>

aAmounts stated are in thousands of dollars.

The district SEV has shown a gradual increase from $8,523 million in the 1967-68 school year to $15,931 million during the 1973-74 school year (the year of this study). The allocated millage from the county remained at 8.68 mills per thousand of county SEV during this period. Local votes raised the millage from 9 mills per thousand of district SEV
in 1967-68 to 14 mills at the time of the science study. This reflected a slow and consistent growth in property value along with a gradually increased millage rate.

Ranking among the southwest Michigan school systems for the 1972-73 school year in dollars per student in operational expenditures (Citizens' Advisory Committee Report, 1974) is shown in Table 4.

Table 4

<table>
<thead>
<tr>
<th>Rank of Case Study Among 36 Southwest Michigan School Systems: 1972-73</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dollars per Student</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>State equalized valuation</td>
</tr>
<tr>
<td>Total tax millage</td>
</tr>
<tr>
<td>Instruction</td>
</tr>
<tr>
<td>Administration</td>
</tr>
<tr>
<td>Operating</td>
</tr>
<tr>
<td>Maintenance</td>
</tr>
<tr>
<td>Fixed charges</td>
</tr>
<tr>
<td>Capital outlay</td>
</tr>
<tr>
<td>Transportation</td>
</tr>
</tbody>
</table>

It was noted that high rankings in fixed charges may be attributed to the fact that there were nine portable classrooms in use at the high-school complex. The transportation cost may have been higher, because of split sessions in grades 6 through 12. Students in each division had separate starting and dismissal times, which meant buses had to travel

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over the same route six times each day. A very low ranking in operational cost resulted from the building being in use for 10 hours per day.

As shown in Table 5 (Citizens' Advisory Committee Report, 1974), the percentages of dollars spent were not particularly different from those in other county school districts except, as pointed out previously, in fixed charges and transportation.

Table 5

Distribution of Expenditures (Dollars in Thousands): 1971-72

<table>
<thead>
<tr>
<th>Expenditure</th>
<th>County Total</th>
<th></th>
<th>Case Study</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dollars</td>
<td>Percent</td>
<td>Dollars</td>
<td>Percent</td>
</tr>
<tr>
<td>Instruction</td>
<td>9,689.4</td>
<td>67.7</td>
<td>755.1</td>
<td>65.6</td>
</tr>
<tr>
<td>Administration</td>
<td>546.0</td>
<td>3.8</td>
<td>44.4</td>
<td>3.9</td>
</tr>
<tr>
<td>Operating</td>
<td>1,044.5</td>
<td>7.3</td>
<td>75.7</td>
<td>6.6</td>
</tr>
<tr>
<td>Maintenance</td>
<td>395.8</td>
<td>2.8</td>
<td>35.7</td>
<td>3.1</td>
</tr>
<tr>
<td>Fixed charges</td>
<td>438.8</td>
<td>3.1</td>
<td>60.6a</td>
<td>5.3a</td>
</tr>
<tr>
<td>Transportation</td>
<td>921.7</td>
<td>6.4</td>
<td>111.1</td>
<td>9.6</td>
</tr>
<tr>
<td>Capital outlay</td>
<td>286.1</td>
<td>2.0</td>
<td>29.5</td>
<td>2.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>14,304.9</strong></td>
<td><strong>100.0</strong></td>
<td><strong>1,151.8</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

*Includes fringe benefits, insurance, and rental of portable rooms.

Table 5 shows the distribution of expenditures for the 1971-72 school year both on the county-wide and case-study bases. A comparison of percentages of dollars spent for the various aspects of education shows that the percentage of
dollars spent in the case study district was near the county average. The system was spending their percentage of dollars earned in much the same way as other districts in the county. This would support the idea that this school system was similar to other rural districts in terms of the money it received and the percentage of dollars it expended in each cost area.

Board of education

The board of education was composed of seven members, elected at large from the district. The president was a realtor and had served for six years, serving the last two years as the board president. The secretary for the board had served nine years and was employed as a bookkeeper at the family golf course. The treasurer had served on the board of education for five years and was a mathematics teacher in another school district. A fruit farmer had served for two years as the legislative representative. The trustees were a blueberry farmer, who had served four years, and a fruit farmer, who had served one year. A college student was an appointed member. She was the only black person on the board and was completing her student teaching at the time of the study.

During the preceding five years, local support of the board of education was evident with the millage issues in that they all passed with "yes" votes on the first ballot.
However, the school district had not been able to pass a bond issue for additional classroom space. In 1968 and 1970, attempts had been made to pass a bond issue to erect a new school building, and it failed each time by several hundred votes. A citizens' committee was established by the board of education in 1972 to survey community attitudes toward a building program and other citizen concerns as they relate to the schools. The committee made recommendations to the board of education in the areas of buildings, curriculum, finance, personnel, population, transportation, and citizen concerns.

Results of the report were negative as they related to the administration in the case study schools. The report was critical of a lack of communication by school officials and stated the citizens' concern that their views were not being heard. In the aftermath of the report, as mentioned above, the middle- and high-school principals resigned, and the contract of the superintendent was continued but not extended. The board of education was relatively unchanged; in the election, all members were returned on a platform dedicated to change the leadership of the schools.

Teaching staff

Teachers in the system were dissatisfied with the curriculum offerings. This dissatisfaction was reflected in a growing concern over the lack of continuity, scope, and
sequence between the elementary-, middle-, and high-school curricula as well as between staff representing these levels.

The following letter from a teacher was included in the Citizens' Advisory Committee Report (1974):

As I see it, the Case Study Middle School has no correlation with the Elementary or with the High School. It seems that we do not have a curriculum for the continued growth through elementary, into junior high and on through high school. We need a curriculum such that we, as teachers, can help the child to progress in an orderly, coordinated program. Since there are so many differing opinions as to what should be taught related to all subjects, among professional staff members, I suggest a professional from outside be brought in to help make some of the decisions in planning such a curriculum. (p. 1)

This opinion was supported by other teachers in the educational association, as evidenced by the fact that during negotiations a proposal to establish a curriculum council was part of the contract negotiated for 1973-74.

The mandate for change came from three groups: the citizens, by means of the citizens' committee report; the reelected board of education members, who had promised the people a change in the programs; and teachers. This teaching staff had requested of the board of education a process for change by negotiating a curriculum council into the contract and by a pledge of $250 to support the council's work.

Test results

A demand for change was further reinforced by the results of the standardized tests in science which had been

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administered in May, 1973, for grades 6-9. These test results in science achievement are reported in Table 6.

Table 6
Standardized Test Results for Grades 6-9

<table>
<thead>
<tr>
<th>Grade</th>
<th>Number of Students</th>
<th>Students Below National Average</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>108</td>
<td>82</td>
<td>75.9%</td>
</tr>
<tr>
<td>7</td>
<td>136</td>
<td>85</td>
<td>62.5</td>
</tr>
<tr>
<td>8</td>
<td>126</td>
<td>93</td>
<td>73.8</td>
</tr>
<tr>
<td>9</td>
<td>103</td>
<td>69</td>
<td>66.9%</td>
</tr>
<tr>
<td>Total</td>
<td>473</td>
<td>329</td>
<td>69.6%</td>
</tr>
</tbody>
</table>

The tests were administered in grades 6-9. There were 108 sixth-grade students tested, and 82 (75.9 percent) were below grade level. In grade 7, 106 were tested, and 85 (62.5 percent) were below the grade level. In grade 8, 126 students were tested, and 93 (73.8 percent) were below grade level. In grade 9, 103 students were tested, and 69 students (66.9 percent) were below grade level. This report clearly indicated that of the 473 students tested, 329 were achieving below grade-level expectations, and that 69.6 percent of the students tested were not meeting the objectives established for the standardized test in science.

A need for change

The administrators, including the superintendent and
three principals (two of whom were newly appointed), met to discuss the problem. Pressure was being placed on the administration as a result of the citizens' committee report, and at each board meeting appeals were being made by the leaders of the citizens' committee to the board of education for action.

Science was selected as the area to begin working on the changes for several reasons. English classes in grades K-5 had adopted the Houghton Mifflin Reading Series for individual instruction during the previous year. Mathematics classes in grades K-5 had received new texts two years earlier. The social studies program relied almost exclusively on periodical materials. Much discussion had related to changes needed in the science area.

When consolidation of the district had taken place, teachers brought with them any science text in use. The *World of Living Things*, a 1955 copyright, had served as the basic text for the seventh grade until 1973, for nearly 20 years; during this time, knowledge had nearly doubled. No science texts were used in grades K-5. During the summer of 1973, the middle-school science books had been placed on the floor during cleaning. Custodians, thinking the books were no longer of any use, had burned the texts. Upon discovery of this, the superintendent, after some discussion, suggested that the problem be submitted to the board of education. The following proposal was recorded in the board of education
minutes for December, 1973:

**Proposal Submitted to Board of Education**

It is proposed that in order to make the needed changes for the Fall, that there be a committee established at once to review programs available. The committee would look at new materials, prepare a guide for teachers and make necessary recommendations as to materials needed.

It is proposed that two elementary, one middle school and one high school teacher and one administrator meet twice a week for six weeks, for the purpose of preparing the basic approach. It is further recommended that four parents, two middle school students and two high school students also work on the committee. It is with clear understanding that this group would then assess the total science program and make recommendations. The teachers would then continue to meet to help prepare guides.

It is further recommended that this committee meet during the school day from 9:00 a.m. to 4:00 p.m. This would make it possible to involve all levels of teachers and students with minimal disruption. It is realized that substitute teachers would be necessary to achieve this goal. The idea of extra pay may be more interesting to the Board, but the general feeling is that time is the most important commodity in this study.

The goals of the project were to develop a coordinated science program for grades K-12, to make recommendations for change, and to implement these necessary changes. Recommendations were to include the materials and the teacher preparation needed. The study was also to serve as a model so that other departments could utilize it in attempts to update their own respective areas. It was the desire of the board of education that such studies be done on a regular and continuing basis. Once the proposal was passed by the board of education, the selection of the committee was begun, which
will be discussed in Chapter III.

Summary

The readings in science would support the idea that science education has passed through several stages. This school system was at a point in curriculum development where teachers taught from their own knowledge and what was available to them. No texts were found in the K-5 program, and there were no basal materials. The middle school was at the point of curriculum development whereby the text provided the basis of instruction. There was no written curriculum, and the text and teacher knowledge provided the necessary instructional materials. At the same time, the State of Michigan was at another point of curriculum development in that behavioral objectives were written. The three stages, then, were all represented in the school system being studied as the study began. This study was a part of the ongoing process in science curriculum development, and all three stages provided information and background for the study.

Chapter II supported the need established in Chapter I with historical background relating to science curriculum studies and further elaborated on the characteristics of this school system. The chapter reviewed the background of the rural setting, gave a description of the land, and, hopefully, provided additional insight into the economics.
of the school district. Slow growth, both in population and in resources of the schools, was reflected in the material. Support of the people for the schools was reflected in their support of the operating millage and in their interest in improving the system. It was this support that led to the formation of the science study committee and its work, which forms the next chapter of this investigation.
CHAPTER III

THE SCIENCE STUDY COMMITTEE

Phase I of the science study committee (SSC) included identification and confirmation of the need for such a group. As recorded in Chapter II, pressures were exerted on the board of education by teachers and citizens, which resulted in the board's resolution to establish the SSC. This action was supported by the administration.

Chapter III, following the introduction, is divided into five sections: Phase II, selection of committee members; Phase III, committee meetings; Phase IV, curriculum review; Phase V, material selection; and Phase VI, final report.

The first section, entitled "Selection of Committee Members--Phase II," includes the procedures used in determining potential members, criteria for selection, and the description of individual members. Section two, entitled "Committee Meetings--Phase III," describes the meetings of the committee, its problems, and the establishment of goals. It contains the major inputs, as viewed by this writer, that influenced the committee as they began to evaluate the existing science curriculum. Phase III also discusses how various groups perceived their roles in the process of science curriculum development.
The third section, called "Curriculum Review—Phase IV," is a step-by-step description of how the committee developed their final goals and how they developed objectives for the various grades. The fourth section, "Material Selection—Phase V," will include the criteria used to select materials, how the selection process was used, and how decisions were made for the chosen materials. "Final Report—Phase VI," will review the procedures used in presenting the science curriculum study results to the board of education and final recommendations to the board of education.

Selection of Committee Members—Phase II

Phase II included the selection of the committee which was to consist of the following 13 members: 4 parents, 4 students, 4 teachers, and 1 administrator. The resolution by the board of education called for the specific size of the committee, but did not give direction as to the method for selecting the members. Consequently, a selection method was determined by the superintendent.

Step one in the committee selection process was a meeting called by the superintendent of the three building principals and the president of the teachers' association. The purpose of this meeting was to select teachers for the SSC. Six criteria for selection were discussed and agreed upon:

1. Teachers representing as many science backgrounds as possible had to be selected.
2. The teachers chosen had to have varying backgrounds in length of service, age, and grade level taught.

3. Elementary staff had to be representative of both the main and smaller schools in the system.

4. Members of the staff had to be willing to serve.

5. The members had to be articulate.

6. Members had to be agreeable to work with parents, students, and administration in developing the program.

The first two members were selected from the secondary division where teachers were departmentalized. The high-school representative selected was the science department chairman and chief negotiator for the Teachers' Education Association, who had pressed for the establishment of a science study committee. He had served as department chairman for several years. His teaching area, and hence his area of interest, was in the biological sciences. He had been a teacher in the system for seven years and was very articulate about the science program. He had good rapport with parents and students and was willing to serve. The second teacher representative was from the middle school and had been teaching for three years. His college emphasis was in the area of physical science. He had good rapport with parents and students and was willing to serve on the committee.

It was more difficult finding staff from the elementary
division to serve on the committee. A review of the teaching credentials of the staff revealed that no teacher in the elementary schools held either a major or minor in science. Teachers selected, then, by definition would not have a formal university background in science. The elementary principal tried to assess the informal knowledge of the teachers and of their expertise as manifested in teacher behavior. Staff members who took the initiative to be informed about science and to present science experiences and experiments in their classes were criteria used by the principal to infer science expertise. The upper elementary division was represented by a teacher who had been involved in several rocket experiments with students. He also was very interested in ecology and outdoor science, was articulate, and worked well with parents. The lower elementary division was represented by an experienced teacher who had served as the head teacher in the 6-room elementary school for 22 years. She taught first grade and questioned the value of any science study. Her major concern was reading, and she viewed science, if justified at all, as a support to the reading program. She was articulate and worked well with both parents and students.

The teachers selected to the SSC were all Caucasian. It was important to note that there were no minority teachers on the staff, although 20 percent of the students were from minority groups. It was the superintendent's suggestion that
representation for minorities come from students and parents. A second group to be represented in establishing the SSC was the administration. Criteria used for selection were: (1) experience in development and writing of curriculum, (2) willingness to serve on the committee, and (3) a strong science background.

The newly hired middle-school principal met the criteria and was selected. In addition, he was a former science teacher and had served previously on several science study committees. His first duty was to appoint the remainder of the committee. This ended the first step in committee selection. The remainder of the appointments took place in step two and began with the selection of the students to serve on the committee. Criteria used were: (1) willingness to serve and grades acceptable to allow them to miss classes, (2) a cross-section of interest in science as reflected by science classes they had taken, (3) the ability to represent other students with their views, and (4) willingness of parents to allow students to serve.

These students selected included a male high-school junior who planned to major in science in college and a black female high-school sophomore who had taken only one science class. The middle school was represented by two females from the eighth grade. These girls had been selected by the student commission from a list prepared by the staff. Since some science background was required of all students, interest
or non-interest in science was determined by the teachers. Consequently, two lists of students were prepared, one each of high and low interest in science. The student commission chose one name from each list by a vote. Students selected were contacted by the commission president and the principal. The students expressed a willingness to work on the committee, and their parents gave permission for them to participate.

Selection of parents to serve on the SSC was the final step; the criteria used for parent selection were as follows: (1) interest in school curriculum, (2) representativeness of the community, (3) representativeness of the various occupations, and (4) representativeness of parent concerns as expressed by the citizens' advisory committee.

The principals and the president of the teachers' association selected the parent members in the final step. A retired businessman, who had served on the citizens' committee, was chosen first. He was very vocal and regularly admonished the board of education for its lack of foresight in curriculum matters. The second member chosen had also been active on the citizens' committee; she was a housewife with four children attending school at the time of the study. These two former citizens' committee members had previously done extensive review of the curriculum guides developed in other communities. Since the report of the citizens' committee had stimulated this project, it was considered advisable to include two of the committee parents as members
of the SSC. The third parent was a local black minister, respected in the black community and their spokesman in local matters. A fourth member was a housewife with three children in the elementary school. The parents selected had children in all four elementary buildings and both secondary buildings. These parents represented all of the vocal factions that regularly addressed the board of education.

As finally constituted, the committee was as representative of the community as the administration perceived possible and included parents, teachers, students, and administrators. Once the process of committee selection was completed and a date for the first meeting established, Phase II of the study was complete. Phase III of the study began with the first meeting of the SSC.

**Committee Meetings—Phase III**

The first meeting of the SSC took place on Tuesday, January 15, 1974, at 9:00 a.m. This was the only meeting time during the study that all members were present. Meeting twice weekly created problems of keeping members informed, yet avoiding repetitious information at the beginning of each session.

Step one of the committee work was an evaluation of the existing science program. This was accomplished by the following actions:
(1) The superintendent and committee members were supplied with students' Metropolitan Achievement Test results for science and reading. Because the reading levels of the students were crucial to the program's success, both science and reading test results were studied.

(2) Committee members discussed the low achievement level and reviewed the test questions. They tried to determine what skills were being tested and why student scores were so low. As a result, the committee agreed that more information was needed from the elementary teachers on what skills were currently being taught.

(3) Parent representatives on the committee supplied the following list of desired educational objectives that had been prepared by the citizens' committee as part of their previous study:

**Educational objectives.--The school will:**

a. Develop skills and understanding in reading, writing, spelling, listening, and speaking.

b. Develop skills and understandings in mathematics.

c. Develop the ability to think critically and to use the scientific method of inquiry.

d. Develop an understanding and appreciation of the way our country grew and of its basic cultural, social, intellectual, political, and economic ideals and values.

e. Develop understandings, appreciations, and values necessary to being an effective citizen in our democracy.
f. Develop an understanding and appreciation of other peoples of the world.

g. Develop an understanding and appreciation of family life.

h. Develop the basic skills, attitudes, and understandings related to movement and contribute to the development and maintenance of good physical and mental health.

i. Develop desirable skills, understandings, and attitudes related to safety.

j. Develop an understanding and appreciation of our scientific age and develop skill in the use of science laboratory equipment and techniques.

k. Develop good study habits, a sense of personal responsibility for learning and skills of using resources.

l. Develop a knowledge and appreciation of the aesthetics.

m. Develop a willingness and ability to use leisure time wisely.

n. Develop respect for other people and the skills necessary to get along with other people.

o. Develop ability and willingness to live by desirable moral and ethical standards.

p. Develop an understanding and respect for the work-a-day world, the industrial age, and knowledge of the vocational opportunities in our society.

q. Develop in students an understanding of their own abilities in our society, and assist them in making intelligent educational and vocational choices.

r. Develop a wider and more skillful use of community resources such as library-museum services, civic theatre, symphony, recreational facilities, and health and welfare organizations.
The above educational objectives were more comprehensive than science, and this fact was recognized by the citizens' committee. Parents from the committee pointed out that this was what they wanted.

This first meeting of the SSC was important because it provided much of the related information that would be used in determining the needs of a science program as shown by test results. In addition, the parents were given the chance to express the goals and objectives that they wanted for the science program. It also made the committee aware of a need for more information from the teachers.

As a result of the committee's first meeting, a questionnaire was sent to all elementary teachers to determine what was being taught in science (Appendix A). The questionnaires were to be returned to the committee within a week. It was believed that the group would be ready by the next meeting to discuss the results of the questionnaire. This information was to provide the basis for further teacher input in the process of establishing basic information for the study. The committee also had requested that copies of all science texts in use be brought to the next meeting. During their discussion, an awareness of varying positions on the committee began to develop. Teachers, parents, and students were not in agreement as to the function of a science program. Four basic questions developed during the first two days of the study that had to be resolved:
1. Was science to supplement reading programs?
2. Was science a completely different area?
3. Was science college-preparatory?
4. Was science for daily living skills?

The committee spent a great deal of time on clarification of member roles and discussed the function of the science program.

Parents and students expressed a desire for a science program more relevant to daily life. Further, they were concerned about the quality of the present program as reflected in the low achievement scores. The meeting continued with a discussion of the goals of the study and a review of the material to be evaluated. There was general agreement that science must complement the reading program and be correlated with the mathematics program, especially at the elementary level.

Teachers were very concerned that classrooms were presently overcrowded and closed space did not exist to store their present materials. Therefore, the teachers expressed concern about a program that required extensive storage space.

One parent tried to impress on the group that science is a process rather than a product. As a retired chemical engineer, he related that it was the method of science, not the material, that was important. The material and the process, he said, must be the elements of prime importance.
This position was to become very important in the later stages when final goals were being developed.

Students were concerned about the preparation they were receiving for college. Former students had returned from college over the Christmas vacation and complained about how much difficulty they were having with science courses. One of the parents, whose son had been recently graduated, supported the view. She complained that he lacked skills in science which were required for his university studies.

There was general agreement that thinking skills were needed by the students and that students did not understand how the scientific method was applied. The committee also agreed that the state and national assessment objectives could provide a basis for the curriculum. Discussion also centered on the curriculum guides of other school systems that were supplied by the citizens' committee. These guides were given as examples of resources that could be of help to the committee showing how other schools had written their curriculum.

The next process consisted of a review of the questionnaire that had been sent to the elementary teachers. This questionnaire had been distributed as part of a regular teachers' meeting and was to be returned the next day. Completed questionnaires were returned on time by 95 percent of the teachers.

Subsequently, the SSC meeting dealt with a review of
what was being taught in the various grade levels. As revealed in the elementary questionnaires, some of the findings were that no text was used in grades K-5, and most of the teachers followed interest areas. Geology and dinosaurs were subject areas taught almost every year. Weather was taught by several teachers. Rocks and various field experiences in ecology were included as part of the learning experience of some students. There was no grade where personnel agreed on what was to be taught within that level. The teachers usually made their own materials or simply used whatever library materials were available. No teachers had a guide to use, but several expressed the hope that the committee could develop such instruments.

Curriculum Review—Phase IV

It was decided by the SSC to establish goals for the entire program beginning with the terminal skills for high school. Intermediate goals had to be determined in order to reach the terminal goals. These intermediate goals would then become the grade level goals. At this point, it was assumed that all terminal skills could be broken down into a series of steps that could be followed at each grade level as a means to reach the desired terminal skills.

The SSC tried to determine the skills or aptitudes in science that were desirable for a normal high school graduate. The committee used as basic materials the teacher
questionnaire results, Metropolitan Achievement Test score results, and state assessment test results. In addition, curriculum guides of several school systems supplied by the citizens' advisory committee, science goals published by the State of Michigan, and goals established by the national assessment were reviewed to determine what a "normal" high school graduate should know.

The librarian had requested science material from several publishers, and approximately 40 texts with accompanying teacher guides had arrived. These texts and guides were studied to determine what was being taught in various grade levels. Each committee member reviewed approximately five texts and guides and reported to the SSC on their findings. In several cases, goals and objectives for the series were available in teacher guides. After committee discussion, texts and guides were exchanged by members for further study.

The committee listed on the blackboard the skills, goals, objectives, and aptitudes that they thought were necessary for the schools' science program. At this point, there was no attempt to organize or limit ideas. Next, the committee grouped common ideas under the following five headings: (1) thinking skills, (2) scientific method, (3) physical tools, (4) instruments of science, and (5) abstract tools.

It is important to point out that the SSC had not
attempted to differentiate goals and objectives. This would have led to some difficulty in writing the final grade level materials.

From the five related science areas, the committee studied how these applied to the entire science program. They found that these five areas were not clearly defined. Therefore, it was necessary to develop a final list of goals based on the five general science areas.

Once these goals were determined, they were written on large sheets of paper and placed on the floor so that everyone could see them. From these goals, certain grade level skills were determined and noted on the papers. The state science objectives were placed in grade level areas. Goals and objectives from other sources such as tests, texts, and curriculum guides were placed in what committee members thought were the appropriate grade levels. The lack of committee knowledge of writing educational goals and objectives became apparent at this time in the difficulty people had in putting their ideas in writing. They relied on other sources for the goals that were written.

As suggested by the teachers on the committee, objectives were moved on the chart from place to place to correlate with the reading and mathematics programs. This helped clarify and aided in achieving the final goals of the study. However, there was some loss of interest and ability to contribute to the desired outcome at this point by parents.
and students, because they did not have the necessary background for determining grade-level placement of materials. Parents and students did assist the teachers in making sure that all previously discussed points were included and aided in finding ideas in guides and texts that could be added to the program.

The committee progress in some areas such as physical tools took only one or two meetings. The terminal skills that the students should have were determined, and the steps needed to achieve the goal were written. The teachers then helped place the progression of skills needed into grade levels. If the skill was one that needed mathematic skills, the level where those mathematic skills were taught was discussed and a sequence developed so that the skill areas could work to reinforce learning. This process was not as rapid in abstract skill areas. The committee could not divide ideas such as appreciation of science into skills and then assign the skills to a grade level. After three meetings, it was agreed that the abstract ideas of science would have to be taught or reinforced at all levels, and therefore it should be the responsibility of all teachers to develop these ideas. This process led to a question of individual student needs in science.

Parents, while concerned about college science requirements, were also interested in a realistic approach for non-college bound students. What type of programs would meet
the needs of all students? Parents wanted problem-solving skills as the basis of the program. The retired man was very strong in his conviction that the subject matter was not as important as the method used to solve the problems. This position led to a strong push for the early introduction and use of the scientific method and the tools related to its use.

Following the committee's placement of their ideas onto the sheets, the grade level guides were typed. There was a two-week delay to have the typing completed and to share the program being developed with the remaining teaching staff. The SSC presented their ideas to the teachers at a staff meeting and asked the group for suggestions as to modifications that were needed in skill areas, objectives, or goals that were assigned. Teachers were also given the commercially produced materials for review and a working draft of the grade level materials. They were asked to view the commercially available text and curriculum guides of other schools. Information was gathered from the staff meeting, and a final draft was compiled and presented to the SSC.

After completing this process, the committee began to search for materials that would meet the goals and objectives they had established. To do this, five basic criteria were established. The committee then developed a series of questions related to the authorship, organization, content, science readiness and graduation, development of scientific
method and attitude, illustrations, and teacher aids. Phase V discusses this aspect of the study.

Material Selection--Phase V

The criteria used by the committee in selecting materials were as follows: (1) grade level objectives must be met (see Appendix B); (2) material for the teaching staff must be acceptable; (3) reading levels must be appropriate; (4) material must meet state guidelines in the area of approved texts; and (5) text material must be reviewed, using the following format:

A. Authorship

1. Are the authors experienced in teaching science at the elementary school level?

2. Have the authors had practical experience in curriculum planning and construction?

3. Have the authors prepared a chart for their entire series of books giving evidence of such careful planning?

4. Are the books sound in scholarship?

B. Organization

1. Is there a structural, sequential arrangement of subject matter which will bring unity and significance to a study of each selected topic?

2. Is the series organized around actual "Areas of Living" subject matter?

3. Are these areas repeated consistently from grade to grade?

4. Does the study of the environment gradually expand from grade to grade from the immediate surroundings to the entire world?
5. Can the areas covered be justified in terms of probable contribution to the objectives of elementary education in general and science education in particular?

6. Does the organization of the text stress continuity of learning?

7. Is there evidence that the series was built on adequate research and practical experimentation on the part of the authors?

8. Does the text provide a balanced treatment of all appropriate fields of science, or is there disproportionate emphasis on some fields to the neglect of others?

C. Content

1. Is the content valid and technically accurate?

2. Is the character of motions, explanations, and illustrations consistent with acceptable principles of learning?

3. Is there an appropriate balance between information supplied and experiments provided?

4. Do the materials arouse interest and encourage the energetic study to science problems?

5. Is it apparent that social implications of science are pointed out wherever possible?

6. Do the materials help children to observe with interest the make-up of their own environment?

D. Science readiness and graduation

1. Do vocabulary, sentence length, and paragraph length grow gradually from grade to grade?
2. Is the subject first introduced through pictures alone, then through pictures and labels, and as a third step through pictures and simple related sentences?

3. Is reading difficulty in accord with grade placement?

4. Are necessary science terms clearly pointed out for special emphasis?

E. Development of scientific method and attitude

1. Are many opportunities provided for critical analysis, application of principles, discussion, formation of hypothesis and conclusions and independent thinking?

2. Are pupils constantly encouraged to put into practice skills in problem solving?

3. Are evaluation techniques suggested?

4. Is guidance into independent study and experimentation encouraged?

5. Does the text encourage "search-discovery" activities in other books, in audio-visual aids, and in local environment?

F. Illustrations

1. Do the illustrations stimulate pupils to think for themselves?

2. Do they suggest experimentation?

3. Do they encourage observation of the actual environment?

4. Are the illustrations placed on the page so as to enhance rather than hinder readability?

5. Is the quality of printing and art work superior so that pictures are sharp and clear?

6. Is a variety of illustrations provided to maintain interest?
7. Are there artists' drawings in color as well as black-and-white?

8. Are drawings scientifically accurate as well as pleasing to the eye?

9. Are there photographs in color and in black-and-white?

10. Were the photographs obviously taken for the purpose of illustrating this series of books?

G. Teacher aids

1. Is an effective plan provided so that teachers may know what has been taught in preceding grades and what will be taught later?

2. Is there a scope and sequence chart?

3. If not, would the organization of the series permit the construction of such a chart?

4. Is provision made so that teachers may know the grade placement of each book but pupils will not?

5. Is a teacher's edition of each book available?

6. Do manuals provide practical helps for teachers?

7. Are adequate suggestions made for outside readings for teachers? for pupils? for visual aids?

8. Do the books provide a wide variety of learning aids and teaching devices?

9. Are suggestions made for displays and exhibits through which the teacher can encourage continuing pupil interest in science work and equipment?

After establishing their grade level goals and a tool for evaluating materials as outlined above (see Appendix B,
"Science Curriculum Guide"), the committee's task was to find a text or series of texts that would meet the needs of the various grade levels. They found that no series available to them met all of the grade level objectives. There was some confusion as to whether the SSC should then re-do the curriculum to meet the best series or to try to supplement the series that was chosen. After much discussion, the second method of supplementing was agreed upon.

After discussion, the following points came out with regard to adopting the series and changing the established goals to meet the series. Arguments for adopting the series were: (1) it would be easier for teachers to use a single text; and (2) the text would meet most of the goals of the committee, and the scope and sequence of the series would ensure reinforcement of ideas at all levels.

The arguments against adopting one series as the text were: (1) program and teacher flexibility would be lost; (2) the local input would not be there to provide for individual differences; and (3) the local control by the staff would be lost.

Therefore, after a full day of discussion, the method of a text and supplemental material was agreed upon. The committee expressed the idea that this would help ensure local control and input.

Five texts and series of texts were chosen by the committee and sent to the teachers for review. The teachers
were asked to use the textbook reviewing form referred to above. To determine reading grade equivalency, the five series were also sent to the three reading teachers. This process of teacher input took three weeks and resulted in four evaluations on each of the elementary series. The middle-school materials were reviewed by the three science teachers and a single evaluation given on each series.

The elementary teachers, middle-school teachers, and the SSC agreed that there was no one series that they had reviewed which would meet all criteria established. This led to the following recommendations. First, a basic text would be adopted; second, a supplemental text would be recommended at the middle school; and third, supplemental materials would be written at both elementary and middle-school levels. After this review, the SSC recommended that grades K-6 adopt a basic science series, People Concepts Processed, by Harcourt Brace. For the seventh- and eighth-grade science classes, several texts were selected: Challenges to Life Science, by McGraw-Hill, was the basic text to be used in grade 7; and Earth Science, also by McGraw-Hill, was selected for grade 8. Areas and the number of units to be taught in grades K-6 are shown in Table 7.

To meet additional objectives, supplemental texts were chosen for the seventh and eighth grades. Grade 7 was a life science program using IIS; Life Science, by Prentice-
Table 7
Science Units for Grades K-6

<table>
<thead>
<tr>
<th>Unit</th>
<th>Number of Units in Subject Area by Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K</td>
</tr>
<tr>
<td>Motion and rest</td>
<td>3</td>
</tr>
<tr>
<td>Man</td>
<td>1</td>
</tr>
<tr>
<td>Heat</td>
<td>2</td>
</tr>
<tr>
<td>Light</td>
<td>3</td>
</tr>
<tr>
<td>Electromagnetism</td>
<td>2</td>
</tr>
<tr>
<td>Earth and space</td>
<td>1</td>
</tr>
<tr>
<td>Matter and atoms</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>12</td>
</tr>
</tbody>
</table>

Hall; and Challenges to Life Science, by McGraw-Hill. Grade 8 was IIS; Physical Science, by Prentice-Hall; and Earth Science, by McGraw-Hill. Grade 9 was to develop a physical science elective to be added to the program.

Committee members examined the submitted materials and determined that a number of the committee's objectives had not been met. A final effort was made to develop additional instructional materials and to supplement the adopted text materials with other resources being used by the system's classroom teachers. Results were varied, but most of the supplementary materials came from the upper-elementary levels. These materials included dittos, experiments from other texts, and field experiences developed during the period when no text was available. Teachers were asked to submit materials

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by grade level and objectives to the committee. Efforts were then made to establish suitable levels at which these materials and objectives could be used. As a result of these efforts, a guide to supplemental materials was prepared which included the objectives to be highlighted. This collection of ideas was distributed to the system's teachers. It was suggested to teachers that these materials be kept in looseleaf notebooks so that additional materials could be added as they were developed by teachers.

The SSC ceased to meet biweekly because the experiments were being gathered by the school district's classroom teachers serving on the committee and the parents and students expressed a lack of expertise in this area. Teacher efforts resulted in the development of a resource guide, which included experiments and ideas on how to present science concepts to children. This project lasted about six weeks, but was viewed as being of considerable value for the teachers who used the supplemental instructional materials. When this aspect of the study was complete, the total committee met one time to prepare a final report to be presented to the board of education, and to review what had been accomplished.

Final Report--Phase VI

A final meeting of the SSC was held to prepare a report of their findings to the board of education. Their final
report was presented at the regularly held March meeting of the board of education. The report of the findings was divided into six areas:

I. Illustrations of the deficiencies in the then-current curriculum.

A. Lack of continuity of ideas.
B. Some teachers emphasize science, others don't even teach science. Bases for emphasis are determined by individual teachers.
C. There is the possibility that a child could go through the entire elementary program without even having science experiences.
D. Some students, because of chance, could be exposed to the same material repeatedly.
E. There are no basic goals for elementary science, or for middle-school science.
F. There is a complete lack of basic objectives for the elementary students to achieve. There are no guidelines so that teachers could know what a student would be expected to know at any particular level.

II. Committee ideas on what is expected of children in achievements at various levels of their school careers.

A. What is expected that a child know upon entering the middle school?
B. What is expected that a child achieve in the middle school? It seems reasonable to expect that:

1. The middle school meet the needs of the child who is leaving school after the 8th or 9th grade.
2. The middle school meet the needs of the child who is entering high school, but does not intend to go on to college.

3. The middle school meet the needs of the child who is entering high school and is going to college.

III. Inclusion of the State Science Guidelines in Michigan and the basic ideas behind those guidelines. Emphasize that they represent minimum goals.

IV. Illustrations of what the committee and teachers attempted to accomplish by way of developing a curriculum guide (Appendix B).

A. Added to the minimum of the state guidelines.

B. Added to the state minimums in the area of "Tools" and "Use of Tools."

C. Matched the objectives to the various grade levels.

D. Matched the objectives to the grade levels at which supplemental materials were being used.

E. Developed a curriculum that had continuity from grade level with final goals spelled out.

F. Considered the needs of system students.

V. Presentations of the materials: books, lab manuals, equipment, and other resources that were believed to be needed.

VI. Estimations of the total costs for the current year and for subsequent years.

The various parts of the final report were handled in the following manner: Part I was presented by the parents,
Part II was presented by the teaching members, Part III was presented by the students, Part IV was presented by the teachers, Part V was presented by the parents, and Part VI was presented by the administration.

After the board of education had discussed the proposals, the report was accepted, and participants in the study were asked for recommendations. The superintendent recommended adoption of the report and adoption of the text materials and guidelines as official materials of the system. All of the materials presented were adopted by the board of education.

Summary

Chapter III discussed Phases II-VI of the study. Phase II, selection of the committee members, reviewed the criteria used to select the committee members and briefly described the members. Phase III, committee meetings, described the meetings and highlighted important decisions of the group. Phase IV, curriculum review, described how the committee established the goals and then the grade-level objectives that were later adopted. Phase V, material selection, gave the criteria used for text materials and the form used to evaluate texts that would be selected. Phase VI, the final report, provided an outline of the procedure used to present the findings of the committee's work to the board of education. This chapter answered the following questions:
1. What methods and procedures did this science study committee use?

2. What changes in materials and procedures were a result of this study?
CHAPTER IV

IMPLEMENTATION, STATUS, AND RECOMMENDATIONS

The preceding chapters have been devoted to the pressures that led to the curriculum revision program within the school system which is the focus of this study. The first chapter recorded how different elements within the community exerted pressure on the board of education to make a change in science curriculum. The second chapter answered the question of how science curriculum change has passed through a series of stages throughout the history of education in the United States. The third chapter recorded how this particular community went about selecting a group of people to review and rewrite the school system's science curriculum, and the problems met by this committee in developing and writing down the goals of the school science program.

Chapter IV builds on this background and gives a status report as viewed by the teachers. Also, records of the middle-school test results one year after implementation of the science curriculum are presented and discussed. Attention is also directed to the problems dealt with in the first year of implementation and, lastly, based upon this information and what is generally known about effective curriculum revisions, recommendations for future study and
investigation are set forth.

Implementation

The presentation of their proposal to the board of education was the last official act of the science study committee (SSC). At that point, school system administrators were charged with the responsibility for ordering those resources and, with the teachers, shared the task of implementing the program objectives approved by the board of education.

Almost immediately, during the implementation year, there were difficulties experienced in three areas. First, the texts and supplemental materials did not arrive on schedule, and the laboratory materials which did arrive were missing numerous items. As a result of delays in delivery, several months elapsed before the materials were ready for teacher use, and teachers' efforts to teach science were frustrated by those delays. The second problem was the poor quality of printing by a local center and of many of the teacher-made materials; though usable, their poor quality deterred teachers and students from optimal effective use. Ultimately, however, each of these problems was resolved, although they contributed to the frustration of both teachers and administration as they sought to carry out the board's charge.

The third obstacle centered around the need for
in-service education of teachers, a provision that had not been a part of the SSC recommendations or the board's resolution. Although teacher retraining was part of the original definition of curriculum improvement, in-service had not been discussed or recommended by the SSC. It was assumed by the teachers that the administration would provide time for in-service training. Such a program was needed especially for the elementary staff, where the teachers had little formal science background. During the preparation of materials for the new science classes, the teachers had expressed concern that the program was open-ended and that they needed help in implementation. However, the only time provided for in-service was during the regular 1-hour teachers' meetings. Moreover, there was no attempt made to involve outside personnel in the implementation of the materials due to the high cost of such programs.

At the elementary level, where materials other than the texts were stored in a central hall area, an attempt was made to share grade-level materials and thereby reduce costs. While the idea was reasonable, this practice created a problem for teachers who had some difficulty in returning materials and making sure they were in the correct places. There were many complaints expressed to the principal about this arrangement, and also the fact that teachers did not have the materials needed for the program.

In the middle school, where teachers worked as a
department, each teacher was responsible for a given grade level. These teachers did not have the same difficulty that the elementary level teachers experienced in their control of materials. Each classroom became the storage area for its grade-level material, and the storage of materials used in all grades was in a general science stockroom. The availability of materials for the middle school, although slow in arriving, did not seem to create any significant problems for the teachers involved. There may have been several reasons for this difference. First, all teachers in the middle school had strong science backgrounds. Also, the structure of the classes was such that science was the only topic these teachers taught.

In order to determine teacher reaction to the science study and ascertain the possibility for future studies, the administration developed a questionnaire for elementary K-8 teachers. Since there had been no changes in grades 10-12, the high school staff was not surveyed. This survey provided the basis for a status report one year after implementation.

Status One Year Later

One year after the board's adoption of the SSC recommendations and after the initial difficulties of implementation had been partially overcome, a survey (Appendix C) was sent to each of the teachers in the K-8 program to determine how they perceived the success of the science program. The
purposes of the survey were: (1) to determine if the objectives of the science program were realistic or achievable as viewed from the teachers' perspective, and if the teachers viewed these changes as desirable; (2) to examine the assumption that a small school could create and implement a science program to meet their needs while staying within the limited resources of the school system; and (3) to evaluate the method used to develop the science curriculum as possibly being applicable to other subject areas in the school system.

The survey was divided into two sections. The first section was designed for use by grades K-5, all self-contained classrooms. The second section was for grades 6-8, where teachers were departmentalized. At the elementary level, the entire staff of 25 teachers was surveyed. The findings of this evaluation are now discussed.

The first question related to whether the objectives were realistic. A total of 19 teachers answered that the objectives were realistic, 1 reported that they were not, and 5 indicated that the science program was not relevant to their class situation. These 5 faculty members included the librarian and the music, physical education, and special education teachers. Of the teachers who did believe the objectives were realistic, 16 also indicated that they felt they could meet these objectives; 3 reported that they could not. These 3 teachers were all assigned to the fourth grade.
In a later follow-up, these fourth-grade teachers stated that their responsibilities to teach mathematics and reading were so extensive that they did not have the time for instruction in science.

Question 2 related to the teachers' use of the new materials. A total of 23 of the teachers indicated that they did not enjoy the program, 18 of whom cited as a problem the equipment used in the classroom. Such results as these would have been surprising if it had not been for the fact that during the early stages of the study, it was discovered that the teachers at the elementary level (as mentioned above) did not have science backgrounds. Secondly, difficulties were experienced by the staff in the arrival of materials and problems of sharing materials, as discussed earlier. Thirdly, the elementary teachers had neither adopted nor requested changes in the science program for a 10-year period. Lack of request may also have been a reflection of teacher subject-matter priorities, as expressed by the fourth-grade teachers, who stated that reading and mathematics were the priority areas in their teaching.

Questions 5 and 6 related to the students' interest and enjoyment of the program. There was 100-percent agreement on the part of the faculty that the students did enjoy the science program and that the students did carry out the science experiments.

Since one source of motivation for the science
curriculum study was the parents, the seventh question asked if parents were involved. The results indicated that only 4 teachers reported involving parents in the instructional program.

Question 8 related to the amount of time each week that teachers devoted to science instruction. It was assumed that more time spent in science would be a measure of the teachers' satisfaction with the program. A total of 15 instructors stated they used 1-2 hours per week, 9 said they used 2-3 hours, and 1 teacher devoted 5-6 hours to science.

The remaining questions were designed to see if the teachers thought the process for curriculum change was effective with a committee working during school time to write a program. There was 100-percent agreement as to the need for further study, although there was disagreement as to the specific subject areas that needed study. Of the total staff, 17 stated that the evaluation program should take place during the school day. The remaining teachers wanted the studies to be undertaken during the summer or after school.

It was important to note that the middle school experienced many of the same problems related to the delivery of materials as the elementary. With one middle-school teacher responsible for each grade, the material re-supply and control, however was not a problem. Teachers did express a belief that the committee had assigned too many activities
to grades 6 and 7 and that more work in biological science was needed in grade 8. The teachers also stated that the supplemental guide was not used frequently because there were so many activities in the text that they did not need nor have the time for the extra material.

In order to evaluate the influence of the new science curriculum on student achievement in science, standardized tests were administered one year after the implementation of the new program. The tests used were the same tests as administered in May, 1973. Due to the high-school principal's refusal to provide time for the second testing, results were available for grades 6-8 only. Results of both the 1973 and 1974 standardized tests are shown in Table 8.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Number of Students</th>
<th>Students Below National Average</th>
<th>Number</th>
<th>Percent</th>
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</thead>
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<td>63.0</td>
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Table 8
Standardized Test Results in Science for Grades 6-8

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The standardized test results seem to indicate a decrease in the percentage of students achieving below the national average in the area of science in grades 6 and 8. Results of the standardized tests indicated no change in the achievement of grade-7 students after one year in the new science curriculum.

During the first year of the new science program, teaching assignments in the science area remained the same for grades 6-8, as did the physical location of all classes. The student population remained stable, with an average of 10 percent of the students in grades 6-8 entering or exiting during the study. An analysis of the standardized tests used determined the percentage of test questions relative to the subject material covered in each grade (6, 7, and 8), as shown in Table 9. To determine if the test was testing the material being covered in the program, as seen by teachers, the teachers were asked to identify questions on the test that they covered during the year.

Table 9

<table>
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<tr>
<th>Grade</th>
<th>Number of Questions</th>
<th>Questions Related to Material Taught</th>
<th>Number</th>
<th>Percent</th>
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<td>6</td>
<td>78</td>
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<td>43</td>
<td>60</td>
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<td>7</td>
<td>80</td>
<td></td>
<td>33</td>
<td>41</td>
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<tr>
<td>8</td>
<td>80</td>
<td></td>
<td>53</td>
<td>66</td>
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</table>
It would appear, as a result of this survey, that the percentage of questions in the seventh-grade test that relate to the material being taught is lower than those in the other grades. Suggestions as to the method used to determine test results will be discussed in the recommendations.

Summary

The purpose of the study was the detailed examination of the processes involved in the development and implementation of a science curriculum change in a small rural school. Because the subject involved the examination and outcome of human behavior, the research method used was the case study.

This process was started when the board of education, under pressure from local citizens and teachers and reports of low student test scores, created the SSC to develop a new science curriculum and to evaluate the program one year later. The major portion of the present study focused on the efforts of this committee of 13 people (4 teachers, 4 parents, 4 students, and 1 administrator) to establish goals and objectives into a workable curriculum that parents, teachers, and students could view as realistic and usable in their community schools. A final product of the SSC was a science curriculum guide, outlining goals and objectives for science classes in the elementary and middle schools.

The importance of this school system's experience in
curriculum development was in the application of the processes used to other similar-sized school systems.

Questions answered by the study were:

1. The need for a science curriculum study in the school system.

2. Supportive historical data that curriculum change is an ongoing process and that the study was part of that process.

3. Methods and procedures used by the SSC.

4. Changes in materials and procedures as a result of their study.

5. Evaluation of the program by teachers one year after implementation.

A survey was sent to teachers in grades K-8 to determine how they perceived the program one year after implementation. Teachers' reactions were mixed, with weaknesses sighted in implementation, lack of teacher science background, insufficient materials, and inadequate storage space. They were supportive of the method used and requested that a similar method be used in future studies. The following recommendations were made.

Recommendations

It was assumed at the outset that it was possible for a small school system to develop and to institute curricular changes which could satisfy both system and student needs. The weaknesses in the curriculum developed by the school system in this study could be traced to problems in the
processes used. Following are lists of do's and don'ts that this writer established as a result of the study. More specifically, the following "don't list" was developed:

(1) Don't appoint an administrator to serve on the committee who is both new to the system and new to the position of principal. In this study, he lacked a clear understanding of the power structure of the schools and the community. Since parent and teacher pressure had been prime movers in establishing the study committee, the need to understand these pressures was very much needed.

(2) Don't allow power vacuums to develop in the administration. The power structure within the administration was very weak. The superintendent of schools had not received a contract renewal and had not received a raise for the second year of a 3-year contract. As a result, he was not able to give strong direction or leadership to the group. His efforts to control even the administrators was very weak as shown in the high school principal's ability to refuse to follow up the testing program and hold to that position.

(3) Don't allow one person to control the flow of material to the group. In this study, the librarian was allowed to control material that came to the committee. This placed one person in a position to veto materials that he/she did not like or want to supply. There needed to be a more general flow of printed material to the group. This weakness was exaggerated by the lack of experience of the personnel
of the science committee in that they did not request more information.

(4) Don't assume that the people that form the committee have a working knowledge of curriculum development. There were no strong persons on the committee who understood what constituted a goal or objective. This was evident in the final paper: Some grade-level materials were written that did not meet the standard definition of goals or objectives. This was further shown in the committee's decision to use the state objectives in the guide.

(5) Don't give any one person the power to veto the work of the committee. One of the greatest weaknesses in this curriculum revision attempt was the inability to establish basic K-12 test data. The high school principal's refusal to supply follow-up data on the ninth and tenth grades further weakened the study and the ability to evaluate what the new program had accomplished. The whole problem related to a lack of data when the study began. There was a general lack of communication regarding desired and final results between the community and the SSC.

(6) Don't allow distrust to develop between the staff and the SSC. There was a question as to why the high school teachers did not support the committee in gaining test results. Was there a fear of the principal or simply a lack of commitment on their part to support the curriculum change?

Following are some recommendations of do's that grew
out of the insight gained by this study:

(1) Do provide both staff and committee members with pre-service time and effective training. This pre-service should be in the area of how to write goals and objectives and why the study is being undertaken. There needs to be a close tie between the study group and professional staff. If they are involved, the teachers do feel a part of the final result and do use the material as intended.

(2) Do provide a basic format for the committee. This committee had a few local guides and the state and federal objectives. Furthermore, there was a need for a basic model that could be used to pull their ideas together. This model could be of great value for success of similar future studies.

(3) Do provide incentives for the committee to complete the work. There was no special compensation for committee members. Teachers prepared for their classes in addition to spending time working on the study committee. Parents and students donated their time to the committee. This writer would question how many times people would be willing to donate the amount of time involved here, and whether or not it would be of value to provide extra compensation for them as they perform these duties.

(4) Do plan for all groups to participate at all levels, but also recognize the limitations of each group. In this study, there were times when parents and students were not able to participate actively because they lacked the
expertise that was required for aspects of the study. The question, then, was whether to provide them with the necessary background or simply allow for others more experienced to relate to the phase of the study being undertaken.

(5) Do provide for time limits, but be flexible. The committee was given 6 weeks to complete the study. This was not enough time, considering the lack of expertise of the committee members. The need for a time limit did keep the committee members active and gave them a deadline to end the project. However, it also created problems, such as in typing and meeting deadlines, that cut short exploration of other areas.

(6) Do establish system-wide goals for the schools. The system in this study had not really established the overall goals for the school system, under which science would fit. The parents' list of school-wide objectives gives an idea of where the community was at the time of the study. But there was a need for clearly stated goals both for the schools and the science committee. Without this, a great deal of time was spent in establishing such committee goals.

(7) Do identify the specific power structure of the community and of the school system. There was a need in this program to have the commitment from people in these two systems to support the revisions requested. This lack of support and the weakness of the administration contributed to a lack of cooperation for evaluating effectively and
fairly the results of the curricular change.

(8) Do provide for community involvement. The people in this school system expressed many very good ideas, and their ideas were a large part of the final product. The writer found this aspect of the study very rewarding in that the people became involved in the decision-making process.

(9) Do provide or develop a K-12 method of evaluation. One of the problems that became clear to this writer was the real lack of understanding as to where the schools were, achievement-wise. The first questionnaire sent to elementary teachers showed the lack of coordination of effort and pointed out the need to look closely at what is being taught, and why. The study showed a lack of standardized evaluation methods in this system. There were no ongoing test results in science that could be used to assess the present conditions in the school.

When the committee was formed, it was stated that this study would add to the knowledge of science curriculum development in that it would further the knowledge of Stage III development, where goals and objectives are translated into specific action. When the final work was completed, the committee returned to the first level, where the text became the guide. The committee were unable to translate their goals into specific teaching strategies; therefore, they reverted to a text as a safe means to assure continuity of program. This may point up the fact that there has not
yet been developed a means to achieve this goal without the benefit of professional expertise in curriculum development.

There were still several questions related to the research, one of which was: Could a small rural school system write and implement a science curriculum? As a result of this study and given the unique circumstances of this school system, the answer would have to be no. They simply did not have the framework of writing skills or curriculum development skills to write the course of study. They reverted back to a Stage I approach because it was safe and simple: safe because the goals were written for them and they did not have to work them through, and safe because it was ready-printed material. The textbook was a final and safe means of achieving the goal. It was also simple. It required only evaluation of the text and a series of questions that were checked off. Also, to a large degree, it returned the responsibility of decision-making back to the teachers.

The study also pointed to a lack of self-confidence in the community. The basic idea precipitating the revision of science offerings was that the community knew what they wanted. The citizens on the committee expressed some ideas of their own, but soon they also turned to the state and national goals for final ideas. This was interesting—and, to this writer, frightening—in that the people were allowing outside influences to make the final decision on what their
children would be taught, in terms of the goals, and how it would be taught, in the form of adopted text series. This study, as did the earlier work of Gillespie (1973), pointed to a need for administrative support. Why was the principal of the high school unwilling to support this study? It would be interesting to analyze how administrators as a group rank curriculum improvement as an aspect of the school administration. Each curriculum study seems to reach a point and then lacks the administrative support needed to follow through.

The first recommendation, although it does not relate to the priorities, involves the physical structure of the science curriculum guide (Appendix B). For purposes of clarity, it is recommended that a more formal, structured outline form be used throughout all grade levels of the guide. This could improve the ease of implementation and increase understanding on the part of the teachers.

A second, and perhaps more important recommendation, involves the development of the goals and objectives. Goals and objectives as they appear in the guide (Appendix B) do not clearly follow the definitions for those terms. The goals are expressed as subject headings, and the objectives are not consistently written in terms of specific expectations in student performance. An outline for the fourth grade contains only one behavioral objective. The fifth-grade outline is composed entirely of subject headings with no behavioral objectives and, because personnel untrained
in writing goals and objectives constructed the guide, could well account for this weakness. It is recommended that the teachers involved in teaching in the science area be given in-service training in writing goals and objectives. Further, it is recommended that the science curriculum guide be rewritten using the original guide as an outline, but including grades 9-12, and stating objectives to meet each goal in a consistent format.

For the purpose of implementing the new program, it would further be recommended that a course be constructed for each secondary science class and for each elementary-school science unit. Course guidelines should include outlines of units to be taught in order to meet the goals and objectives as written in the new science curriculum guide. These outlines could include suggested teaching activities and a list of suggested regular and supplemental reading materials. It is believed that including applicable supplemental materials in a clear teaching guide would alleviate the problem teachers found in using a separate supplementary materials guide.

Another recommendation involves the storage and utilization of materials. Efforts to share materials were thwarted due to the lack of an organized system for their storage and dispersal. It is recommended that a teacher's aide be employed to handle the care and dispersal of materials and equipment from a central area, such as the library.
In view of the fact that the system's elementary teachers have limited backgrounds in science, it is recommended that an in-service training program for the elementary teachers be considered as a viable means of upgrading their competence in the science area.

It is further recommended that a standardized test be selected or developed that will test the materials being taught at each grade level. The test used during the study was more related to the subject matter in grades 6 and 8, with fewer questions relating to grade 7. It is believed that the test used did not give an accurate assessment of student achievement in grade 7 in that a high percentage of the questions did not relate to the subject being taught.

In order to maintain program effectiveness, periodic meetings are recommended for the purpose of evaluation and the consideration of changes. This would help update the curriculum guide and keep the people working together.

By continuing and completing the task started by the SSC, the school system's experience in curriculum development could be of value to similar school districts.

In conclusion, it is important to highlight the fact that the efforts of the citizens' committee, the SSC, and all of the parents, students, teachers, and administrators working together were able to institute a curriculum which met the goals that had been established for grades K-8. These people, working together, were responsible for
improving part of the program for students in their schools. The success of the program may best be measured in the ability to have diverse groups working toward a common goal for their school.

The project reflects how a small rural school system, by use of its limited resources, developed a program that met national goals while maintaining its own identity. Most certainly, teachers and administrators can, in such a setting, effect curriculum change by the use of a planned, organized method, if in no other way than by the fact that they "choose" to do it their way.
APPENDIX A

Survey Sent to Elementary Teachers by Science Study Committee
What science text material do you have in your room?

What supplemental material do you use?

What are your major areas of interest in science?

What areas of science do you teach?

If you have overviews in science that you use, would you send a copy.

Please return by Thursday.
APPENDIX B

Science Curriculum Guide Developed by Science Study Committee
PREFACE

This guide is an attempt to organize the science material into a logical, ongoing approach. It is hoped that this will result in less duplication and a more systematic coverage of science materials.

Each grade level has been given objectives to achieve, together with a list of applicable activities. These areas are of primary emphasis for the level concerned.

The grade-level guides begin with an overview of the entire program, so that each person will be able to see how their effort joins with the total school effort to achieve a well-balanced program.

It is hoped that teachers will continue to add new materials to this guide as they become available and remove activities as they become obsolete.
# I. THINKING SKILLS

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Kindergarten and First Grade

I. Thinking skills

A. Scientific method

1. Identify the problem (Objective: The child will be able to identify likenesses and differences in visual sets and groups.)

2. Collecting data—distinguishing between relevant and irrelevant (Objective: The child will be able to bring in collections of objects or pictures appropriate to the discussion.)

3. Evaluation of data

a. Comparing likenesses and differences (Objective: The child will be able to distinguish objects on the basis of physical properties.)

b. Observing results (Objective: The child will be able to observe simple changes in a picture or object.)

c. Ranking (Objective: The child will be able to arrange objects or events in sequence, according to prescribed criteria.)

d. Classifying (Objective: The child will be able to sort objects of varying properties into two sets on the basis of a common property.)

e. Formulating a hypothesis

f. Identifying controls and variables

II. Tools for solving problems

A. Physical tools

1. Equipment (Objective: The child will be able to identify and use the following equipment—non-scales balances, magnifying glasses, magnets.)
2. Use of equipment
   a. Weighing (Objective: The child will be able to estimate which is heavier of two objects.)
   b. Time (Objective: The child will be able to tell the hour, half-hour, seasons, and days of the week.)
   c. Pressure
   d. Direction (Objective: Introduction to cardinal direction. The child will be able to tell which direction he lives from school.)
   e. Motion (Objective: The child will be able to demonstrate push and pull.)

3. Reading and writing skills (Objective: The child will be able to read scientific materials and use terminology appropriate to his grade level.)

4. Mathematics skills (adding; subtracting; set comparison; simple linear measurement; cups, pints, quarts; simple bar graph; hour, half-hour; recognition of shapes; estimation; half of a region)

5. Research and library skills (Objective: The child will be able to find picture books and simple reading books on a given subject.)

6. Communication skills (Objective: The child will be able to use communication skills [recording, reporting, summarizing, and evaluating] appropriate to his grade level, as determined by the guide.)

B. Abstract tools

1. Spatial relationships
   a. Location (Objective: The child will be able to locate principal buildings in his community.)
b. Size and shape

c. Weight and mass

d. Motion and rate
Second Grade

I. Thinking skills

A. Scientific method

1. Identify the problem (Objective: The child will be able to further identify likenesses and differences in written and oral material.)

2. Collecting data—distinguishing between relevant and irrelevant (Objective: The child will be able to find materials and objects relevant to a discussion topic.)

3. Evaluation of data
   a. Compare likenesses and differences (Objective: The child will be able to extend the use of the five senses in making observations.)
   b. Observing results—selectivity with relation to a task (Objective: The child will be able to observe changes in temperature of liquids or air using the thermometer. The child will be able to observe characteristics of an object or organism, not visible without a lens, with the use of a magnifying glass.)
   c. Ranking (Objective: The child will be able to arrange objects or events in sequence, according to prescribed criteria.)
   d. Classifying data (Objective: The child will be able to identify a property which is common to one set, when he is given two classified sets.)
   e. Formulating an hypothesis
   f. Identifying controls and variables

II. Tools for solving problems

A. Physical tools

1. Equipment (Objective: The child will be able to use non-scaled balances, magnifying glasses, and magnets.)
2. Use of equipment
   a. Weighing (Objective: The child will be able to make further estimation of weight.)
   b. Time (Objective: The child will be able to tell the hour, half-hour, months of the year.)
   c. Pressure
   d. Direction (Objective: The child will be able to make a simple map of the school ground, using cardinal directions.)
   e. Motion (Objective: The child will be able to do an experiment showing movement.)

3. Reading and writing skills (Objective: The child will be able to read scientific materials and use terminology appropriate to his grade level, as determined by the guide.)

4. Mathematics skills (addition; subtraction; introduction to multiplication; simple volume; bar graphs; metric measurement; hour, half-hour; liquid measurement; set comparison)

5. Research and library skills (Objective: The child will be able to give an oral report on a given subject.)

6. Communication skills (Objective: The child will be able to use communication skills [recording, reporting, summarizing, and evaluation] appropriate to his grade level, as determined by the guide.)

B. Abstract tools

1. Spatial relationships
   a. Location (Objective: The child will know where his home is in the community, and have a basic knowledge of his state.)
   b. Size and shape (Objective: The child will be able to select from a set of two- or three-dimensional objects those which have common properties as to size and shape.)
c. Weight and mass

d. Motion and rate
Third Grade

I. Thinking skills

A. Scientific method

1. Identify the problem (Objective: The child will be further able to identify likenesses and differences in written and verbal material.)

2. Collecting data—distinguishing between relevant and irrelevant (Objective: The child will be able to distinguish between observations which support a problem and those which do not.)

3. Evaluation of data
   a. Comparing likenesses and differences (Objective: The child will extend the use of the five senses in making observations.)
   b. Observing results—selectivity in relation to a task (Objective: The child will be able to observe characteristics of an object not visible without a lens, with the use of a magnifying glass.)
   c. Ranking
   d. Classifying data
   e. Formulating an hypothesis (Objective: The child will be able to make a valid inference, given a set of observations concerning an incident or object.)
   f. Identifying controls and variables

II. Tools for solving problems

A. Physical tools

1. Equipment (Objective: The child will be able to identify several thermometers and handle a microscope.)
2. Use of equipment
   
a. Weighing (Objective: The child will be able to tell weight by pounds.)

b. Time (Objective: The child will be able to tell the hour, half-hour, quarter-hour, days, and months.)

c. Pressure

d. Direction (Objective: The child will be able to make a simple map of the community, with introduction to intermediate direction.)

e. Motion

3. Reading and writing skills (Objective: The child will be able to read scientific materials and use terminology appropriate to his grade level, as defined by the guide.)

4. Mathematics skills
   
a. Measuring—linear, volume, weight (Objective: The child will be able to use these skills.)

b. Basic formulas and calculation (Objective: The child will become efficient in addition, simple division, metric measure, subtraction, area, bar graphs, multiplication, volume.)

5. Research and library skills (Objective: The child will be able to make a simple book report on a given subject.)

6. Communication skills (Objective: The child will be able to use communication skills [recording, reporting, summarizing, and evaluating] appropriate to his grade level, as determined by the guide.)
B. Abstract tools

1. Spatial relationships
   a. Location
   b. Size and shape
   c. Weight and mass
   d. Motion and rate
I. Thinking skills
   A. Scientific method
      1. Identifying the problem
      2. Collecting data
      3. Evaluation of data
         a. Comparing likenesses and differences
         b. Observing results
         c. Ranking most important to least important (the main concept: a cycle)
         d. Classifying data
         e. Formulating an hypothesis

II. Tools for solving problems
   A. Physical tools
      1. Use of equipment
         a. Weighing
         b. Time
         c. Pressure
         d. Motion
      2. Reading and writing skills (Objective: The student should be able to read scientific terminology appropriate to grade level, as defined by the guide.)
      3. Mathematics skills (circle graphs, bar graphs)
      4. Research and library skills
B. Abstract tools

1. Spatial relationships

   a. Location (Objective: The student will be able to understand that living things and their environment are parts of one system.)

   b. Size and shape--ability to construct a model

   c. Weight and mass

   d. Motion and rate
Fifth Grade

I. Thinking skills

A. Scientific method
   1. Identifying the problem
   2. Collecting data—distinguishing between relevant and irrelevant
   3. Evaluation of data
      a. Comparing likenesses and differences
      b. Observing results
      c. Ranking most important to least important
      d. Classifying data
      e. Formulating an hypothesis (from ideas to discoveries)

II. Tools for solving problems

   A. Physical tools
      1. Equipment (microscopes, dissection kits, basic generators and motors)
      2. Use of equipment
      3. Mathematics skills (measuring, weighing, time, pressure, direction, motion)

   B. Abstract tools
      1. Spatial relationships
         a. Location
         b. Size and shape
Sixth Grade

I. Thinking skills

A. Scientific method

1. Identifying the problem (Objective: The student will be able to identify that a problem exists.)

2. Collecting data

3. Evaluation of data
   a. Comparing likenesses and differences (Objective: The student will be able to organize data from an experiment in an orderly written fashion.)
   b. Observing results—selectivity (Objective: The student will be able to describe in writing changes observable in the environment.)
   c. Ranking (evaluation)

II. Tools for solving problems

A. Physical tools

1. Use of equipment (Objective: The student will be able to divide the earth "globe" into the different time zones.)
   a. Direction (Objective: The student will be able to locate positions on a map.)
   b. Motion (Objective: The student will be able to define gravity and show and develop experiments to show its concept. The student will be able to define and multiply.)

2. Reading and writing skills (Objective: The student will develop a vocabulary as is needed for each unit. With this vocabulary each student will be able to record experiments using proper wordage and, if necessary, develop a report.)
3. Mathematics skills (Objective: The student will become familiar with the metric system [measuring, weight] and the relationship of the metric to the American unit of measure.)

B. Abstract tools

1. Environment (Objective: The student will be able to explain variations in the natural environment.)
Seventh Grade

I. Thinking skills

A. Scientific method

1. Identifying the problem (Objective: Given a general area of concern, the student will identify a specific and pertinent problem therein.)

2. Collecting data—distinguishing between relevant and irrelevant (Objective: The student will be able to distinguish between data which are relevant to the stated problem and those which are not.)

3. Evaluation of data
   a. Comparing likenesses and differences
   b. Observing results (Objective: The student will be able to, when making observations, discriminate between valid and invalid data.)
   c. Ranking
   d. Classifying data (Objective: The student will be able to take a group of items or ideas and classify them into major groups and various subgroups according to observable characteristics.)
   e. Formulating an hypothesis (Objective: The student will be able to design and construct an investigation resulting in an hypothesis obtained from the data.)
   f. Identifying controls and variables (Objective: The student will be able to set up controls for an investigation and list the variables that could affect the outcome.)

II. Tools for solving problems

A. Physical tools

1. Equipment (Objective: The student will be able to identify and exhibit the proper use of common laboratory glassware and other equipment.)
a. Bunsen burner (Objective: The student will be able to light the burner and adjust the flame according to the need.)

b. Basic electrical units (Objective: The student will be able to build a simple magnet; know what an electric current is and how it acts in straight and coiled wires; demonstrate the relationship between electrical flow and magnetism; construct a simple electric motor, using direct current.)

c. Glass (Objective: The student will be able to bend glass at 90° angle so that liquids will still pass through.)

d. Laboratory maintenance skills (Objective: The student will be able to handle the proper cleaning of corrosive agents; use the fire extinguishers; properly clean and sterilize glassware and other equipment.)

2. Use of equipment

a. Weighing—use of balances and scales (Objective: The student will be able to use the triple beam and two-pan balance.)

b. Pressure

c. Time—the calendar (Objective: The student will be able to use the geologic time scale and make comparisons between the Julian and New World calendars.)

d. Direction (Objective: The student will be able to identify the following terms—altitude, longitude, zenith, meridian, great circles, International Date Line, Prime Meridian, equinox, solstice.)

e. Motion—acceleration (Objective: The student will be able to work problems determining acceleration due to the force of gravity; explain the concept of inertia; define acceleration and explain the concept; work gravity problems for bodies in space.)--velocity (Objective: The student will be able to define and find velocity.)
3. Reading and writing (Objective: The student will be able to use all reading and writing skills that are appropriate for this grade level as determined by the guide.)

4. Mathematics
   a. Measuring and converting of linear, volumetric, and weight values (converting °F = °C = °K)
   b. Basic formulas and calculation—efficiency in division (Objective: The student will be able to handle all basic formulas and calculations congruent to this grade level.)
   c. Statistics (frequency, mean, mode, median, intervals)
   d. Exponents and scientific notation (Objective: The student will be able to use both positive and negative exponents in calculation.)

5. Research and library skills (Objective: The student should be able to use and evaluate any reference materials available—textbooks, Reader's Guide, dictionary, encyclopedias, books, pamphlets, magazines—and display awareness of current problems.)

6. Communication skills (Objective: The student will be able to use accurately communication skills [reading, reporting, summarizing, and evaluating] appropriate to this level, as determined by the guide.)

B. Abstract tools

1. Spatial relationships
   a. Location—topographic maps (Objective: The student will be able to show, by means of a topographic map, surface features such as streams, valleys, elevations, depressions, ridges, hills, vegetation types, and estimated steepness of grade.)—locations maps (Objective: The student will be able to locate positions by the grid system [longitude and latitude]—section, range, township, etc.)
Eighth Grade

I. Thinking skills

A. Scientific method (Objective: The student will be able to recognize the difference between fact, concept, inference, theory, and hypothesis.)

1. Identifying the problem (Objective: Given a set of issues concerning a situation, the student will be able to identify or establish that a problem exists.)

2. Collecting data—distinguishing between relevant and irrelevant (Objective: Given data contained in an investigation, the learner will identify one difference between those data which are relevant to the investigation and those which are not relevant.)

3. Evaluation of data
   a. Comparing likenesses and differences (Objective: The student will be able to compare likenesses and differences found in various common rocks found in this area.)
   b. Observing results—selectivity with relation to a task (Objective: The student will be able to observe results of tests taken for carbohydrates, fats, and proteins. The student will be able to observe results from tests made on various digestive processes. The student will be able to observe and record results from tests run on respiration and the nervous system. The student will be able to observe and record results on the development of a chicken embryo. The student will be able to observe and record results on the development of a bean plant. The student will be able to observe and record growth rates in humans. The student will be able to observe and record results on human characteristics.)
   c. Ranking (Objective: Given a collection of data obtained by student investigations, the student will be able to rank these data according to relative importance and increasing complexity.)
d. Classifying

e. Formulating an hypothesis (Objective: Given a collection of data obtained through the student's investigation, the student will be able to make interpretations and generalizations.)

f. Identifying controls and variables

g. Inquiry skills (questioning)

II. Tools for solving problems

A. Physical tools

1. Equipment

   a. Barometer (Objective: The student will be able to construct a mercuric barometer; explain the principle of the mercuric and aneroid barometers.)

   b. Standard laboratory equipment identification (Objective: The student will be able to explain and locate low and high pressure systems on a map [isobars]; use the periodic chart in finding information necessary to solve problems in chemistry.)

2. Use of equipment

   a. Weight

   b. Time

   c. Pressure—density (Objective: The student will be able to read the barometer, including vernier scale; explain the principles behind the functioning of aneroid and mercuric barometers; determine the density of a given volume of air.)

   d. Direction

   e. Motion—acceleration (Objective: The student will be able to determine the positive and negative components of acceleration and be able to define acceleration.)
3. Reading and writing (Objective: The student will be able to read and write according to his grade level.)

4. Mathematics
   a. Measuring (linear, volumetric, weight, height, altitude)
   b. Basic formulas
   c. Statistics—frequencies, mode, median, mean, intervals (Objective: The student will be able to determine or calculate frequencies, mode, median, and mean from a given set of data or from data obtained by student investigation.)
   d. Exponents and scientific notation

5. Research and library skills

6. Communication skills (Objective: The student will be able to use communication skills [reporting, recording, summarizing, and evaluating] appropriate to his grade level, as determined by this guide.)

B. Abstract tools

1. Spatial relationships (Objective: The student will be able to identify the purpose of Brunton compass; explain and use the terms "strike" and "dip"; recognize certain geologic structures [synclines, acticlines, and faults]; make cross-sectional maps and models; use symbols to represent different rock types; know what a fault is and what causes it; know where the major fault zones of the world are.)

2. Outdoor science
   a. Identification
   b. Comparisons (Objective: The student will be able to identify major groups of plants common to this area; identify examples of major groups of insects; recognize differences between major groups of animals; identify the physical factors affecting living communities [sunlight, temperature, water,
minerals, topography]; identify soil profiles; identify clouds; identify wind speed by Beaufort scale; identify glacial features.)

3. Size and shape

4. Disciplinary areas (areas of interest and need
   a. Sex education
   b. Evolution (Wong, Idea 2)
   c. Outdoor Science
   d. Genetics (Wong, Idea 3)
   e. Homeostasis (Wong, Idea 4)
   f. How Life is Organized (McGraw-Hill, Unit 2)
   g. Man and His Body Functions (McGraw-Hill, Unit 3)
   h. Challenges to Man's Survival (McGraw-Hill, Unit 4)
   i. Earth science (weather, geology—environmental, oceanography)

5. Appreciation of science
I. Thinking skills
   A. Scientific Method
      1. Identifying the problem (Objective: When faced with a group of ideas and facts, the student will be able to identify the central problem.)
      2. Collecting data—distinguishing between relevant and irrelevant, or the ability to seek data from a wide variety of sources (Objective: The student will be able to demonstrate the ability to seek data from a wide variety of sources, including periodicals, references and books in the library, basic textbooks, Reader's Guide, other applicable sources [resource people, government agencies, industries].)
      3. Evaluation of data
         a. Comparing likenesses and differences
         b. Observing results selectively with relation to a task
         c. Ranking most important to least important
         d. Classifying data
         e. Formulating an hypothesis
         f. Identifying controls and variables
      4. Appreciation of science—recognizing the limitations of science and be aware that man is an integral part of his environment (Objective: The student can demonstrate that he understands that not all problems can be solved by science.)
   
II. Tools for solving problems
   A. Physical tools
      1. Use of equipment
         a. Balances and scales (Objective: Given an analytic balance, the student will be able to illustrate its proper use and care.)
b. Pressure (Objective: The student will be able to demonstrate Charles' Law and explain the concepts involved; explain Boyle's Law and demonstrate the concepts; explain Bernoulli's Principle and demonstrate the concepts involved.)

c. Direction—simple navigation (Objective: The student will be able to find his latitude from the North Star; find his latitude by determining the altitude of the sun at its zenith for any given day of the year; identify the following terms—altitude, longitude, zenith, meridian, great circles, International Date Line, Prime Meridian, equinox, solstice.)

d. Motion—acceleration (Objective: The student will be able to work problems determining acceleration due to the force of gravity; explain the concept of inertia; define acceleration and explain the concept; work gravity problems for bodies in space.)

2. Mathematics

a. Measuring (linear, volumetric, weight)

b. Basic formulas and calculation

c. Statistics (frequency, mean, mode, medium, intervals)

d. Exponents and scientific notation (Objective: The student will be able to use both positive and negative exponents in calculation.)

3. Research and library skills

4. Communication skills (Objective: The student will be able to use communication skills [recording, reporting, summarizing, and evaluating] appropriate to his grade level, as determined by the guide.)
B. Abstract tools

1. Spatial relationships
   a. Location
   b. Size and shape
   c. Weight and mass
APPENDIX C

Questionnaire Used by Administration to Determine Status of Science Program One Year Later
SCIENCE CURRICULUM QUESTIONNAIRE

Please check below, and turn in at the end of the meeting.

Grade you teach __________

Number of classes you have taken in science:

_____ 1-2  _____ 5-6
_____ 3-4  _____ 6 or more

Type of certification:

_____ Elementary  _____ Both of these
_____ Secondary

IN YOUR CLASSROOM

1. Are the objectives established by the science study realistic?

_____ Yes  _____ No  _____ Not applicable

2. Do you feel that you are objective?

_____ Yes  _____ No  _____ Not applicable

3. Do you enjoy using the science program?

_____ Yes  _____ No  _____ Not applicable

4. Do you have the equipment needed to teach the science program?

_____ Yes  _____ No  _____ Not applicable

5. Do your students enjoy using the science materials?

_____ Yes  _____ No  _____ Not applicable
6. Do your students do the experiments?
   _____ Yes  _____ No  _____ Not applicable

7. Do you involve parents in the science program?
   _____ Yes  _____ No  _____ Not applicable

8. How much time do you use in science each week?
   _____ 1-2 hours  _____ 4-5 hours
   _____ 2-3 hours  _____ 5-6 hours
   _____ 3-4 hours  _____ 6 hours or more

9. If another curriculum study were begun, what area would you like to see studied? (ONE ONLY)
   _____ English
   _____ Social studies
   _____ Mathematics
   _____ Science
   _____ Music
   _____ Art
   _____ Physical education
   _____ None of the above

10. When do you think curriculum studies should be done?
    _____ During school time with substitutes
    _____ After school
    _____ During vacations
    _____ Summer time
REFERENCES


Paparello, I. N. Junior high school science guidelines for curriculum improvement. *Education Abstracts*, 1966. (University Microfilms No. 67-2829)


RELATED READINGS


Bertran, A. L., & Von Brock, R. C. (Eds.). Models for educational change. Austin, Tex.: Southwest Educational Development Laboratory, 1968. (Monograph 2)


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Karplus, R. What's new in curriculum physical science. *Nation's Schools*, 1969, 84, 35-36.


