AN ANALYSIS OF THE SCIENCE SUPERVISORS' ROLE IN THE SELECTION AND USE OF SCIENCE CURRICULUM MATERIALS

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ABSTRACT

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by Glenn David Berkheimer

Problem

The purpose of this study was to determine and analyze the role of the science supervisor in the selection and use of science curriculum materials as viewed by science supervisors and teachers involved in the implementation of programs utilizing: (1) the National Science Foundation (NSF) sponsored science project materials, and (2) the commercial science curriculum materials.

The two-part problem consisted of: first, determining whether the views of the above two professional groups differed concerning the relative importance of the characteristics of science curriculum materials and of the objectives of science education in selecting science curriculum materials; and secondly, determining whether these two groups differed in their responses to actual and recommended behaviors of the science supervisor in implementing programs utilizing science curriculum materials.

Procedure

A two-part questionnaire corresponding to the two parts of the

problem was structured to obtain responses on a five-point scale, pretested, revised, and mailed to a national sample of 464 science supervisors including the members of the National Science Supervisors Association who were involved in the implementation of NSF sponsored and commercial science curriculum materials and to a random sample of 508 elementary and secondary teachers under their supervision. In addition, questionnaires were mailed to 306 members of the Association for the Education of Teachers of Science.

The percentages of questionnaires returned were 68.4 from science supervisors, 69.0 from teachers, and 62.2 from college science educators. Statistical treatments used were chi square, intraclass correlation, and Spearman rank correlation coefficients.

Findings

Selection of Science Curriculum Materials

The findings indicate differences at the 0.05 level (with the chi square test) between professional groups using NSF sponsored science project materials and those using commercial science curriculum materials. An analysis of response frequencies within contingency tables of significant questionnaire items indicates that the professional groups using commercial science curriculum materials place greater importance on curriculum materials which emphasize: (1) teacher demonstrations, (2) science content units, (3) qualitative observations and explanations, (4) science facts and principles, and (5) explanations to develop concepts. A similar analysis of the significant questionnaire items indicates that the professional groups using NSF sponsored science project materials consider those curriculum materials to be of greater importance which emphasize: (1) the individual laboratory approach to teaching and learning, (2) the use of laboratory experiences as the primary source of information, (3) the elements of scientific methods, (4) the quantitative approach to science education, (5) the investigative approach to concept development, and (6) tests that measure the child's ability to use the methods of scientific inquiry.

Actual Behavior of Science Supervisors

Comparisons were made of response frequencies from elementary and secondary school science supervisors and teachers using NSF sponsored science project materials and from those using commercial science curriculum materials on significant questionnaire items describing science supervisory behaviors in implementing science curriculum materials. Both elementary and secondary school personnel indicated that:

A. Science supervisors using commercial science curriculum materials more frequently encourage teachers to use science demonstrations.

B. Science supervisors using NSF sponsored science project materials more frequently (1) support teachers who try new curriculum materials; (2) encourage teachers to use individual laboratory experiences with pupils; (3) encourage teachers to experiment with new ideas and practices in teaching science; (4) arrange for released time to enable teachers to attend in-service programs; (5) report to teachers after they attend a professional meeting; and (6) are actively involved in educational research.

Elementary and secondary school personnel view the role of the science supervisor differently. Both elementary and secondary school personnel using commercial science curriculum materials were in better agreement on the supervisory activities than similar groups using NSF sponsored science project materials. The degree of agreement among secondary school personnel was greater than among elementary school personnel.

Recommended Behaviors of Science Supervisors

Analyses of responses indicate that science supervisors and teachers using NSF sponsored science project materials differ at the 0.05 level from those using commercial science curriculum materials regarding the recommended behaviors of the science supervisor concerning the frequency with which he identifies and discusses problems or weaknesses in the science program with the teachers; encourages teachers to use demonstrations or individual laboratory experiences with pupils; and meets with teachers to plan changes in equipment, supplies, and resources for a changing curriculum. Items were rated higher by professional groups using NSF sponsored project materials except for those items that dealt with teacher demonstrations.

The recommended behaviors of the science supervisor are viewed differently by college science educators than by science supervisors or by teachers. College science educators, in general, recommend a more passive leadership role for the science supervisor than do teachers or science supervisors.

Summary

Many differences found between science supervisors and teachers

using NSF sponsored science project materials and those using commercial science curriculum materials are apparently related to the elements of scientific methods and the individual laboratory or the investigative approach to teaching and learning of science. Further, those persons using NSF sponsored science project materials apparently perceive a more forceful leadership role for science supervisors than do those using commercial science curriculum materials.

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CHAPTER I

PROBLEM AND ORGANIZATION OF THE STUDY

Science curriculum materials are being changed rapidly because of studies by persons associated with commercial publishers and with projects sponsored by the National Science Foundation (NSF). From these studies two types of programs are emerging. The NSF sponsored science teaching projects emphasize science concepts, the theoretical nature of science, contemporary science, scientific inquiry, the elements of the scientific methods, mathematics to study relationships, and the investigative or laboratory approach to the learning of science. In contrast, the commercial science curriculum programs emphasize teacher demonstrations or group experiences, science content topics, facts and science principles, qualitative observations and explanations to study relationships, and the practical nature of science or technology.

Science supervisors frequently have the responsibility for selecting and implementing the two programs. However, few guidelines have been established as to how the science supervisor would fulfill this responsibility.

If the purpose of science supervision is the improvement of science teaching, and if science curriculum materials are important aids in the improvement of science teaching, one may conclude that teachers who are supervised are more likely to be successful in using science curriculum materials than teachers who are not supervised. This concept should have extensive application in science education, although several questions need to be considered. How do the activities of science supervisors who are implementing NSF sponsored science project materials differ from those implementing[1] commercial science curriculum materials? Do science supervisors and teachers using NSF sponsored science project materials differ from those using commercial science curriculum materials as to the relative importance of characteristics of science curriculum materials? Do these two professional groups[1] of science supervisors and teachers agree on the objectives of science education? The answers to these and similar questions would be valuable to school personnel who select science curriculum materials, to NSF sponsored project teams who prepare science curriculum materials, to science educators who train science teachers and supervisors, and to persons interested in supervision.

The National Science Supervisors Association (NSSA) has established a Commission on the Role of the Science Supervisor and problems related to the supervisor's functions have been discussed at the last three annual NSSA conventions. The present study was conducted in cooperation with the above Commission and should contribute to its work. It complements rather than duplicates the Commission's effort; the Commission's concern is to determine the role of the science supervisor in general, whereas the purpose of this study is to determine the science supervisors' role in relation to the types of curriculum materials being used in the nation's schools.

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[1]The definitions of terms are presented on pages 10, 11, and 12.

Statement Of The Problem

The role of the science supervisor is to assist teachers to improve the teaching and learning processes by the interpretation of what science is and how it fits into the overall educational pattern, by the interpretation of the objectives of science education, by the selection of science curriculum materials, and by the performance of tasks which demonstrate methods of teaching science. But does the type of science curriculum materials being implemented affect the science supervisors' role?

The problem, then, was to determine whether science supervisors and teachers using the NSF sponsored science project materials perceive the role of the science supervisor differently than do those using commercial science curriculum materials. The study researched those science supervisory activities that are closely related to the selection and implementation of science curriculum materials: namely, activities related to curriculum, leadership, in-service programs, and equipment-materials.

Specifically, the problem had two parts. Part I dealt with the relative importance of characteristics of science curriculum materials and of the objectives of science education in selecting science curriculum materials as perceived by the above two professional groups. Part II pertained to the actual and recommended behaviors of the science supervisor in implementing science curriculum materials as viewed by these two groups.

In addition Part II of the study determined whether elementary and secondary school personnel perceived the role of the science supervisor differently.

Background of the Problem

The rationale for this study can be demonstrated through the history of supervision, theories of supervision, supervisory practices, role theory, objectives of science education, and current changes in science curriculum materials. Although the literature related to the first five of the above topics is reviewed in Chapter II, some information concerning these topics is necessary here to aid the reader in understanding the background of the study.

The history of supervision indicates that supervisors have played an important role in selecting and implementing curriculum materials. But history also reveals that the philosophy, theory, and practices of supervision have changed drastically, especially as other facets of education have changed. Apparently supervisors exhibited much stronger leadership in the improvement of instruction before 1930 than they did between 1930 and 1950. Probably the more forceful leadership of the early special supervisor had been necessitated by the introduction of new programs or curriculum materials.

Current literature provides abundant evidence that curriculum development project materials differ widely from those in common use just a decade ago. For example, Snygg has stated "that the information explosion and the scientific developments which have triggered these projects require revolutionary changes in the goals and methods of instruction as well as changes in subject matter".[2] New science curriculum materials have certainly played an important role in this

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[2]Donald Snygg, "A Learning Theory for Curriculum Change," Using Current Curriculum Developments, A Report of ASCD's Commission on Current Curriculum Developments (Washington, D. C.: Association for Supervision and Curriculum Development, NEA, 1963), p. 109.

revolution. According to the literature, school personnel and college science educators are keenly aware of the differences in these materials.[3,4]

In light of the historical evolution of supervision and the impact of widely different science curriculum materials upon science education, it is logical to expect science supervisory activities to change. There is little information on how these duties might change.

Although many authors agree on the objectives of supervision,[5] they disagree on the specific supervisory activities necessary to fulfill these objectives. Then, too, it is difficult to describe accurately the functions of supervision today because the role of the supervisor is changing. MacKenzie underlines the changing role of supervisors by stating:

> In this age of unrest and revolution, the school supervisor has not been left undisturbed. Forces are at work which are reshaping supervisory positions and placing new demands on all instructional leaders who would not be bypassed in the rush of educational developments.[6]

The changing role of the supervisor and the forces causing the change are outlined in the 1965 Yearbook of the Association for Supervision and Curriculum Development (ASCD) which emphasizes in the final chapter the importance of curriculum leaders as change agents:

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[3]"New Science Curriculums: How to Get Your District Ready," School Management, VII (June, 1963), 59.

[4]J. Stanley Marshall, "The Improvement of Science Education and the Administrator," The New School Science, A Report to School Administrators on Regional Orientation Conferences in Science (Washington, D. C.: American Association for the Advancement of Science, 1962), p. 6.

[5]Ross L. Neagley and N. Dean Evans, Handbook for Effective Supervision of Instruction (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1964), p. 1.

[6]Gordon N. MacKenzie, "Role of the Supervisor," Educational Leadership, XIX (November, 1961), 86.

> Analyses of the functions of the curriculum leader make quite central his role as an inducer and coordinator of change. The designation "change agent," perhaps more than any other, reflects this key responsibility. If the supervisor and the curriculum worker are, indeed, change agents, then it becomes a matter of great importance that they be able to help chart the direction of change and to keep track of it.[7]

This concept suggests that more forceful leadership from supervisors will be required than was evident from 1930 to 1950. Is it possible that the development of new curriculum materials will again promote forceful supervisory leadership?

Although the 1965 Yearbook criticizes the development of curriculum materials by subject area specialists, there is certainly evidence of the impact of NSF sponsored curriculum projects. In commenting on the relationship of educators, subject area specialists and the development of curriculum materials, the yearbook states:

> Many educators were by and large bypassed, especially curriculum directors, supervisors, superintendents, university specialists in teacher education and others. The perception of these subject matter specialists often was that such "generalists" were not needed. Nor were many of the professional educators particularly ingenious in devising ways of becoming involved in the new movement. . . .
> Yet, if we really intend to change and improve the curriculum in America, such professional educators are essential to widest acceptance and implementation of the worthwhile in the reconstructed content and methodology fostered by the subject matter specialists.[8]

The above statement implies the need for a subject area supervisor who can select the best thoughts for improving a curriculum in a specific discipline from both the subject matter specialist and the professional

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[7] Paul R. Klohr, "Looking Ahead in a Climate of Change," Role of Supervisor and Curriculum Director in a Climate of Change, the 1965 Yearbook of the Association for Supervision and Curriculum Development (Washington, D. C.: ASCD, 1965), p. 150.

[8] William Van Til, "In a Climate of Change," Role of Supervisor and Curriculum Director in a Climate of Change, the 1965 Yearbook of the Association for Supervision and Curriculum Development (Washington, D. C.: ASCD, 1965), p. 26.

educator.

Although the increase in the number of supervisors employed has probably intensified the confusion on the role of the supervisor,[9] some broad guidelines concerning the function of supervisors have been described. Supervisory activities appear to be related to curricula, leadership, in-service programs, self-growth, public relations, selection and use of materials, evaluation, and research.

The modern approach to supervision is to help teachers help themselves. A supervisor should work with teachers in a way that demonstrates the approach he advocates that the teachers use with the students. If, for example, he believes that a science teacher should develop a scientific attitude, experimental-mindedness, and curiosity, he too must exhibit these attitudes and traits. The science supervisor must think constantly in terms of educational objectives, the objectives of science education, and the child in his day to day actions. Stotler points out that modern science

> Supervision is an expert professional service which is primarily concerned with the improvement of learning. Thus, supervision deals with the improvement of the total teacher-learning process; orients learning and its improvement within the general aim of education; and coordinates, stimulates, and directs the growth of teachers through cooperative leadership. It is deeply concerned with the long-range improvement of science education.[10]

The broad responsibility of the science supervisor is to work with the teachers, administrators and others to bring the best possible learning

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[9]Reba M. Burnham and Martha L. King, Supervision in Action (Washington, D. C.: Association for Supervision and Curriculum Development, NEA, 1961), p. 31.

[10]Donald Stotler, et al., "The Supervision of the Science Program," Rethinking Science Education, Fifty-Ninth Yearbook of the National Society for the Study of Education, Part I (Chicago: University of Chicago Press, 1960), p. 226.

experiences to the child. But how can responsibilities be fulfilled most efficiently and effectively? How can the science supervisor use the above guidelines in developing specific activities and programs to improve the teaching and learning of science?

Need for the Study

The need for clarifying the role of the science supervisor becomes obvious as one tries to apply these general guidelines to specific situations. Yet relatively few studies have been conducted to determine the science supervisor's responsibilities; and some of these studies seem to offer conflicting findings. For example, there is some question concerning the effect of science supervisors or consultants on student achievement. Humphreys[11] used consultants with seventh and eighth grade science teachers and found reduced student achievement. A similar study in mathematics education, however, produced much different results. DeVault, Houston, and Boyd[12] used consultants with 89 teachers of intermediate mathematics and found that teacher and student achievement were significantly related to the total consultant time spent with the teachers.

Several studies concerning the duties of science supervisors have contributed some information that was of value in identifying pertinent

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[11]Alan H. Humphreys, "A Critical Analysis of the Use of Laboratories and Consultants in Junior High Science Classes" (unpublished Ph.D. dissertation, University of Texas, 1962), pp. 1-137.

[12]M. Vere DeVault, W. Robert Houston, and Claud C. Boyd, "Do Consultant Services Make a Difference?" School Science and Mathematics, LXIII (April, 1963), 285-290.

supervisory activities for this study. For example, Lee[13] evaluated the activities of secondary school science supervisors in terms of established values procured through the judgements of a jury of science educators. Harwell[14] surveyed teachers and Ploutz[15] surveyed science supervisors to identify the responsibilities of the science supervisor. Wrobleski[16] prepared a directory of secondary science supervisors in large school systems and surveyed them to identify their responsibilities. A review of these and other studies in Chapter II indicates that much remains to be done to determine the role of the science supervisor.

Although millions of dollars have been spent within the last decade developing science curriculum materials to improve elementary and secondary education, no study has been conducted to determine the role of the science supervisor in implementing NSF sponsored science project materials as compared to implementing commercially planned materials. Yet the impact of curriculum materials such as textbooks on the science program can hardly be denied,as Blackwood states in a recent national survey for the U. S. Office of Education:

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[13] Verlin Wiley Lee, "The Evaluation of Supervision of Secondary-School Science Instruction" (unpublished Ph.D. dissertation, Ohio State University, 1958), pp. 1-356.

[14] John Earl Harwell, "The Responsibilities of the Science Supervisor as Indicated by Science Teachers" (unpublished Ed.D. dissertation, University of Mississippi, 1961), pp. 1-263.

[15] Paul F. Ploutz, "The Science Supervisor" (unpublished Ed.D. dissertation, Colorado State College, 1960), pp. 1-159.

[16] Bernard E. Wrobleski, "The Duties and Functions of a Science Coordinator in a 9-12 Science program in Selected School Districts in the United States" (unpublished Master's dissertation, Indiana State College, 1965), pp. 1-96.

> Science textbooks play a key role in determining what content is studied in the elementary school. This conclusion is based on the very high per cent of schools that use textbooks very often. From 78.1 to 90.7% of all schools reported that they use textbooks very often. . .[17]

The fact that the National Science Foundation (NSF) has spent millions of dollars sponsoring the development of new curriculum materials indicates that those who administer these funds believe that curriculum materials strongly influence the quality of teaching programs. School personnel also believe this because they change curriculum materials or textbooks in an attempt to improve the instructional program.[18]

If it is the task of the science supervisor to improve the teaching-learning of science and if curriculum materials are instrumental in helping to improve the teaching and learning of science, then certainly it is logical to ask whether there is a relationship between the type of curriculum materials used and the role of the science supervisor whose responsibility it is to implement the materials.

Definitions, Objectives, and Hypotheses

The following are definitions, statements, or assumptions as they are used in this dissertation.

Role, according to Good, is defined as those "behavior patterns of functions expected of or carried out by an individual in a given

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[17] Paul E. Blackwood, "Science Teaching in the Elementary School: A Survey of Practices," Journal of Research in Science Teaching, III (September, 1965), 188.

[18] Henry M. Brickell, A Survey of Changing Instructional Approaches and Descriptions of New Programs in the Public and Non-Public Elementary and Secondary Schools of New York State (Albany, N. Y.: State Education Department, 1961), p. 22.

societal context".[19]

The role of the science supervisor is the actual and recommended behavior patterns of functions expected or carried out by the science supervisor as perceived by science supervisors and science teachers. This role is delimited to activities or behaviors as related to curriculum, leadership, in-service programs, and equipment-materials.

Objectives of science education, as developed in Chapter II, are those that the investigator derived from educational objectives and the nature of science.

Actual behaviors are those behaviors performed by science supervisors, as perceived by science supervisors and teachers.

Recommended behaviors are behaviors that ought to be performed by the science supervisors, as perceived by science supervisors and science teachers.

The selected National Science Foundation (NSF) sponsored science project materials are those produced under the direction of the AAAS Commission on Science Education; the Elementary School Science Project, University of Illinois, Urbana; the Elementary Science Study by Educational Services, Inc.; and the Biological Science Curriculum Study (BSCS).

The commercial science curriculum materials are materials used in elementary school science or secondary school biology that have not been produced under the sponsorship of the National Science Foundation.

Science curriculum materials are materials used in the teaching and learning of science, including textbooks, reference materials, laboratory facilities and equipment, teachers' guides, as well as other

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[19] Carter V. Good, Dictionary of Education (New York: McGraw-Hill Book Company, Inc., 1959), p. 471.

materials prepared specifically for the teacher, the student, or the supervisor.

Implement as used in this study means to accomplish, to fulfill, or to establish the use of a program or curriculum materials in elementary and/or secondary schools.

Professional group refers to science supervisors and teachers using NSF sponsored science project materials or to science supervisors and teachers using commercial science curriculum materials.

Objectives

The purposes of this study were:

1. to determine whether there were differences between science supervisors and teachers implementing NSF sponsored science project materials and those implementing commercial science curriculum materials as to the perceived
   a. relative importance of characteristics of science curriculum materials,
   b. relative importance of objectives of science education,
   c. actual behaviors of science supervisors, and
   d. recommended behaviors of science supervisors;
2. to determine whether elementary school personnel perceived the role of the science supervisor differently than did secondary school personnel;
3. to determine whether the recommended science supervisory behaviors as viewed by college science educators differ from those perceived by science supervisors themselves; and
4. to determine whether the recommended science supervisory behaviors as viewed by college science educators differ from

those perceived by elementary and secondary school teachers.

Hypotheses

H_1 Science supervisors and teachers using National Science Foundation (NSF) sponsored science project materials differ from those using commercial science curriculum materials as to the perceived relative importance of particular characteristics of science curriculum materials (H_1: $CM_1 \neq CM_2$).

H_2 Science supervisors and teachers using NSF sponsored science project materials differ from those using commercial science curriculum materials as to the perceived relative importance of selected objectives of science education (H_2: $Obj_1 \neq Obj_2$).

H_3 Science supervisors and teachers using NSF sponsored science project materials differ from those using commercial science curriculum materials as to the perceived actual behavior of science supervisors (H_3: $AB_1 \neq AB_2$).

H_4 Science supervisors and teachers using NSF sponsored science project materials differ from those using commercial science curriculum materials as to the recommended behavior of science supervisors (H_4: $RB_1 \neq RB_2$).

H_5 The perceived actual behaviors of science supervisors of grades K-6 differ from the perceived actual behaviors of science supervisors of grades 7-12 (H_5: $AB_{ele} \neq AB_{sec}$).

Overview of Procedure and Analyses

The study was designed as an analytical survey using a questionnaire with an International Business Machines (IBM) response sheet as the method of collecting data. Data processing cards were punched directly from the response sheets with mark sensing equipment, and the statistical analyses were achieved through the use of the Control Data Corporation 3600 Computer. In this way, error due to transfer of data and to miscalculations was minimized.

A two-part questionnaire was constructed, pretested, revised, and mailed to a national sample of science supervisors and teachers. Part I of the questionnaire procured adequate information to test hypotheses 1 and 2. In order to determine the items in this section, the objectives of science education were derived from educational objectives[20] and the nature of science. These objectives were the basis for statements and counter statements describing science curriculum materials. Part II of the questionnaire was designed to obtain adequate information to test hypotheses 3, 4, and 5. Items in this part consisted of statements depicting activities of the science supervisor in implementing science curriculum materials. Two responses as perceived by the respondents were made to each statement: the first indicated the actual behaviors of science supervisors; the second indicated the recommended behaviors of science supervisors. Both responses were made on a five-point scale.

Respondents were classified as using NSF sponsored science project materials or commercial science curriculum materials. The hypotheses were tested by applying the chi square test to their responses. Spearman correlation coefficients were used to determine relationships between professional groups implementing NSF sponsored science curriculum materials and those implementing commercial science curriculum materials in each area of curriculum, leadership, in-service programs, and equipment-materials.

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[20] Robert J. Havighurst, et al., Schools for the Sixties, A Report of the Project on Instruction, National Educational Association (New York: McGraw-Hill Book Company, 1963), p. 9.

Assumptions and Limitations

In conducting this study it was assumed that: the objectives of science education could be derived from educational objectives and the nature of science; the respondents answered the questionnaire honestly; the science supervisors who were on the mailing list of this study are typical of science supervisors in the United States; and the science supervisors used the recommended procedure in distributing questionnaires to teachers.

Questionnaire items were developed from the objectives of science education and the literature relating to science supervision; however, there was an element of subjectivity in the judgment of the investigator in determining the items included. This subjectivity is a limitation to the study. Limitations typical of this as well as most questionnaire studies include: the subjectiveness of each respondent categorizing his response to fit the scale, and obtaining information only from the questionnaires returned. Further, the study was limited to the role of the science supervisor in selecting and implementing science curriculum materials.

Organization of the Thesis

Presented in this chapter was the statement of the problem, the background of the study, the need for the study, and an overview of the procedure and analyses. Additionally the assumptions and limitations of the study were presented.

Chapter II contains: the derivation of the objectives of science education used as the basis for Part I of the questionnaire, the review of the literature concerning the role of the general supervisor and the science supervisor which was used as the basis for Part II of the questionnaire, and the implications for this study from the literature.

The design and execution of the study is described in Chapter III, which includes the research design, a description of the preparation and preliminary testing of the questionnaire, the preparation and distribution of the final questionnaire, the follow-up procedures, and the percentage of returns.

The analyses of data and findings are presented in Chapter IV; Chapter V contains the summary of findings, the conclusions, and the implications of this study for future research.

CHAPTER II

REVIEW OF RELATED LITERATURE

The literature in educational supervision reveals that most authors agree on the broad, general functions of the supervisor, but differ as to the specific supervisory activities or tasks to be used in carrying out these functions. In this chapter some of the various opinions which reflect the supervisors' role are reviewed. Though the research concerning the duties and responsibilities of the general supervisor consists mainly of descriptive surveys, a few analytical surveys or objective studies have been conducted.

The chapter of four sections reviews the literature that is relevant to the design of the study and to the construction of the study's questionnaire. The first section reviews the literature in general supervision to indicate recommended supervisory activities and trends in the current literature useful in selecting pertinent supervisory activities for this investigation. The second section, the objectives of science education, was essential to the development of Part I of the questionnaire. The third section relates general supervision and special supervision and filters out the recommended general supervisory activities pertinent to the science supervisor. It also includes studies directly related to the role of the science supervisor. The last section summarizes the information from the literature useful in the design of the study and the construction of the questionnaire.

Role of the General and Special Supervisor

To clarify the meaning of the science supervisors' role as used in this study, it is helpful to consider role theory briefly. Role theory postulates that a school system is a miniature society with administrators, supervisors, teachers, and pupils representing positions or offices within the system. Certain rights and duties are associated with each position and actions appropriate to the position are defined as roles.

Although there are various definitions of role, the definition according to Good is accepted in this study. Good defines role as those "behavior patterns of functions expected of or carried out by an individual in a given societal context".[1] As Gross, Mason, and McEachern point out:

> Three basic ideas which appear in most of the conceptualizations considered, if not in the definitions of role themselves, are that individuals: (1) in social locations (2) behave (3) with reference to expectations.[2]

A supervisor's role, then, is affected by his behavior, by the expectations that others have for his behavior, and the social environment in which he finds himself. The influence of role expectations on the behavior of persons in a position is affected to the degree of their involvement in the group whose expectations are being considered.[3] Assuming, then, that the supervisor has extensive involvement with his

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[1] Carter V. Good, Dictionary of Education (New York: McGraw-Hill Book Company, Inc., 1959), p. 471.

[2] Neal Gross, Ward S. Mason, and Alexander W. McEachern, Expectations in Role Analysis: Studies of the School Superintendency Role (New York: John Wiley & Sons, Inc., 1958), p. 17.

[3] Wilbur B. Brookover, and David Gottlieb, A Sociology of Education (New York: American Book Company, 1964), p. 323.

teachers, their expectations for his behavior would influence his role greatly. If the role expectations of the science supervisor vary greatly among those with whom he is involved, his effectiveness will decrease compared to more consistent expectations. According to Lucio and McNeil there is evidence to support this statement:

> A series of studies shed light on the reciprocal role expectations of teachers and supervisors in the improvement of instruction. . . . Respective roles must complement each other if the objectives of the school are to be accomplished.[4]

As the number of science supervisors increase, greater numbers of teachers and students are affected and it becomes increasingly important to determine the degree of consistency of the expectations for the role of the science supervisors.

The advantage of role theory is that one can determine the role of the supervisor by determining the consensus on the expectations for his behavior. This point is stressed by Gross, Mason, and McEachern:

> The point we have been trying to underscore is that the degree of consensus on expectations associated with positions is an empirical variable, whose theoretical possibilities until recently have remained relatively untapped.[5]

By applying role theory to the science supervisor, one can analyze his role and study relations that might otherwise not be evident.

If the undesirable consequences of role conflict are accepted, the need for clarifying the role of the supervisor becomes obvious.

Since clarifying the role of the supervisor is important to the morale and productivity of all staff members, his role should receive continuing attention by school personnel.

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[4]William H. Lucio and John D. McNeil, Supervision: A Synthesis of Thought and Action (New York: McGraw-Hill Book Company, Inc., 1962), p. 31.

[5]Gross, Mason, and McEachern, p. 43.

School Supervision in the United States
--a Historical Perspective

Supervision in the United States can be traced back to colonial America. The Massachusetts Law of 1642 ordered that children be taught to read so that they could understand the principles of religion. The Law of 1647 further specified that both reading and writing should be taught.[6] In order to better enforce these laws, the Law of 1654 ordered selectmen to exercise some supervision of teachers.[7] These selectmen were to secure teachers of sound faith and morality and continue the teachers in office as long as they met these requirements. As civil authorities gave more thought to the general support of the school, they saw the need for more efficient supervision. Consequently, school committees were charged with the duty of inspecting the schools. For example, in 1709 at Boston, a committee of laymen was appointed to inspect school facilities and equipment, to examine pupil achievement, and to formulate means for the advancement of learning.[8] During the next hundred years committees of this general type functioned to see that both teachers and pupil did not shirk their job. The emphasis, however, was on maintaining existing standards of instruction rather than on improving instruction. By the middle of the nineteenth century "one trend was apparent, that of a shift from lay to professional

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[6] J. Minor Gwynn, Theory and Practice of Supervision (New York: Dodd, Mead and Company, 1961), p. 5.

[7] William E. Drake, The American School in Transition (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1955), p. 71.

[8] A. S. Barr, W. H. Burton and Leo J. Brueckner, Supervision: Principles and Practices in the Improvement of Instruction (New York: D. Appleton-Century Company, Inc., 1938), p. 3.

responsibility for inspection of the schools".[9] This trend increased as villages and cities grew and schools with more than one teacher became necessary. Because of these conditions, head teachers or principals were named and freed from part or all of their teaching responsibilities to enable them to care for the administration and supervision of the schools.[9]

Supervision, whether accomplished by a head teacher, a principal or a superintendent, was regarded as the transmission of superior knowledge. The supervisor decided what should be taught as well as how it should be taught, and inspected the classrooms to see whether his plans were carried out. Early books on administration and supervision afford evidence of this concept of supervision:

> The theory of school supervision which this treatise is designed to illustrate requires the superintendent to work upon the school through the teachers. He is to prepare plans of instruction and discipline, which the teachers must carry into effect . . .[10]

Pickard[11] outlined similar functions of the superintendent.

The changes in supervisory theory from 1870-1950 were summarized by Button.[12] He classified the theories of supervision by five periods, as abstracted by this investigator.

1. Before 1880, the supervisor or superintendent had only the power to advise.

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[9]Mildred E. Swearingen, Supervision of Instruction: Foundations and Dimensions (Boston: Allyn and Bacon, Inc., 1962), p. 18-19.

[10]William H. Payne, School Supervision (New York: American Book Company, 1875), p. 76.

[11]J. L. Pickard, School Supervision (New York: D. Appleton and Company, 1890), p. 63.

[12]Henry Warren Button, "A History of Supervision in the Public Schools, 1870-1950," Dissertation Abstracts, XXII, No. 2 (1961), 797.

2. From 1880 until 1905, it was held that teaching practices were determined by an idealistic philosophy and that supervision was to secure conformity to these practices.
3. After 1905 educational administration was strongly influenced by industrial management methods. During the period from 1905 to 1914 administrators were to make the decisions and the supervisor was to convey instruction to the teacher, and to observe and measure in order to determine the efficiency of the teacher.
4. Because of teacher discontent as a result of these practices, much was written after 1920 concerning teacher morale as an aspect of supervision. During the latter part of the period from 1920-1940, the science of education and scientific supervision were emphasized. This trend grew out of the application of methods of science to research in education and to industrial management problems.
5. Democratic supervision was generally accepted after 1940.

Today supervision is viewed as "assistance in the development of a better teaching-learning situation".[13] Most authors stress democratic supervision, but emphasize different qualities under this general heading. Franseth[14] strongly emphasizes leadership; Lucio and McNeil[15] stress supervision as the vehicle for bringing all educational theories into

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[13] Kimball Wiles, Supervision for Better Schools (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1955), p. 8.

[14] Jane Franseth, Supervision as Leadership (New York: Row, Peterson and Company, 1961), pp. VII + 376.

[15] William H. Lucio and John D. McNeil, Supervision: A Synthesis of Thought and Action (New York: McGraw-Hill Book Company, Inc., 1962), pp. XI + 282.

consistent practice; Wiles[16] and Bartky[17] view supervision as human relations; and some authors[18,19] seem to emphasize several areas such as leadership, human relations, skill in group processes, and evaluation. Neagley and Evans have summarized the current professional literature on supervision in relation to its history.

> The professional literature of the past decade is full of the theory of modern supervision. Terms such as "democratic," "team effort," and "group process" have been lavishly used in an attempt to show that present-day supervision is a far cry from the autocracy supposedly exhibited by the early twentieth-century administrator and supervisor. According to the theorists, all decisions of any importance in the modern school system should involve the entire staff, and each professional employee must feel that he is a part of the team. . . . The image of democracy in action at the school and district level has been planted very firmly by the writers of almost every book in the field.[20]

Perhaps this attempt to overcome the autocratic image of the past accounts also for the difference in emphasis as to how forceful or how passive supervisory leadership ought to be.

The Special Supervisor

The history of supervision illustrates that supervisory theory and practice have changed rapidly, especially when forces are acting to change education. Although special supervision has a much shorter history than general supervision, the supervisory theories and practices

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[16] Wiles, pp. XV + 399.

[17] John A. Bartky, Supervision as Human Relations (Boston: D. C. Heath and Company, 1953), pp. XI + 308.

[18] Hanne J. Hicks, Educational Supervision in Principle and Practice (New York: The Ronald Press Company, 1960), pp. VI + 434.

[19] Fred C. Ayers, Fundamentals of Instructional Supervision (New York: Harper and Brothers Publishers, 1954), pp. XI + 523.

[20] Ross L. Neagley and N. Dean Evans, Handbook for Effective Supervision of Instruction (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1964), p. 4.

of general supervision and special supervision tend to be similar at any one period of history.

Beginning about 1870 a number of new subjects, including music, drawing, manual training and home economics, were strongly emphasized in the public school curriculum.[21] Because teachers had not learned the content or the methods necessary to present these subjects to their pupils, they were hesitant about teaching them. These teachers then turned to their administrators and supervisors for help, but found that they too were not sufficiently familiar with the new subjects to help them. As a result, the new subjects were either taught by special teachers or by regular teachers with the assistance and general guidance of an expert who became known as a special supervisor.

In discussing supervision in the latter part of the nineteenth century Swearingen stated:

> . . . many new subjects were introduced into the curriculum and even prepared teachers felt inadequate when asked to handle the new fields. Special supervisors were often added to the staff to show teachers how to give instruction in the new areas.[22]

Ayers indicates the same trend:

> Special supervision expanded rapidly, particularly in the larger cities. By 1925 practically all cities of 100,000 and over were giving some type of special supervision to physical education, music, art, manual training, home economics, and penmanship. Smaller cities followed the practice until the place of special supervision was established throughout the country.[23]

Supervisors of the Regular Subjects

During the period in which the number of special supervisors

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[21]Ayers, p. 9.

[22]Swearingen, p. 19.

[23]Ayers, p. 10.

increased, supervisors of regular subjects were also being employed. Ayers and Barr conducted a survey of regular subject supervisors in forty-four American cities of at least 100,000 population and reported that in 1923 there were 19.5 supervisors employed in these cities in science, 12.5 in commercial subjects, 8.5 in English, 6 in foreign language, 4 in social studies and 2 in mathematics.[24] In 1932, Beauchamp recognized the importance of science supervisors by stating that courses of study prepared under the guidance of a science supervisor or a curriculum director were more effective than those formulated with no supervision.[25]

During the late thirties, according to reports on large city school systems by Rawlins,[26] Wildman,[27] and Wilt,[28] the science supervisors' role had extended to include coordinating responsibilities. In 1946 Carleton[29] reported a study which included the duties and responsibilities of science supervisors in forty-eight large cities. Apparently

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[24]Fred C. Ayers and A. S. Barr, The Organization of Supervision: An Analysis of the Organization and Administration of Supervision in City School Systems (New York: D. Appleton and Company, 1928), pp. 23-24.

[25]William L. Beauchamp, Instruction in Science, U. S. Dept. of Health, Education, and Welfare, Office of Education, Bulletin No. 17, Monograph No. 22 (Washington: U. S. Government Printing Office, 1932), p. 3.

[26]George M. Rawlins, Jr., "A Science Supervisor in a Large School District," Education, LIX (March, 1939), 439-442.

[27]Edward E. Wildman, "A Science Supervisor in a Metropolitan Area," Education, LIX (March, 1939), 437-439.

[28]Margaret L. Wilt, "The Science Advisor Plan in Chicago," Science Education, XXIV (March, 1940), 146-148.

[29]Robert H. Carleton, "An Investigation of the Director or Supervisor of Science in the Public Schools," Science Education, XXX (February, 1946), 19.

the science supervisor's function as a coordinator continued but he shared the responsibility with building principals and department heads.

Since supervisory theories and practices of special supervision at any one period of history tend to be similar to those of general supervision, this study assumes that science supervisory practices reflect trends and emphases of general supervision.

The General Supervisor

What duties of the general supervisor are mentioned most often in the literature dealing with supervision? As was stressed in Chapter I, most authors agree on the over-all function of supervisors, but differ as to the specific activities or tasks that supervisors ought to perform in order to fulfill these broad functions. In addition, two authors may list the same supervisory activity, but give it a different relative emphasis in the total role of the supervisor. In spite of these differences, a study of supervisory activities emphasized by various authors is helpful in accumulating probable activities that contribute to his role.

The quoting of many authors regarding supervisory activities, however, would be repetitious and unnecessary; a few representative examples will be sufficient to illustrate the recommended supervisory activities found in the literature. Franseth states that supervisory activities include "individual and group conferences, schoolroom observations, participation in school and community activities, demonstration lessons, co-operative teaching, talks, reports, home visits, interviews".[30]

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[30]Franseth, pp. 82-83.

Although Swearingen[31] does not give a definitive list of supervisory activities, she does deal with committee meetings, curriculum development, evaluation, group meetings both small and large, individual conferences, induction of new teachers, interpreting the school programs to the public, the selection and use of materials, and research as the functions of the supervisor.

Wiles and Bartky place more emphasis on human relations than on specific supervisory activities. For example, Wiles states:

> To improve instruction the supervisor must provide: leadership that develops a unified school program and enriches the environment of all teachers; the type of emotional atmosphere in which all are accepted and feel that they belong. . .[32]

Bartky,[33] in dealing with the interplay of teacher-supervisor personalities, indicates that the supervisor stimulates teachers to improve their teaching, attempts to fit the method to the individual teacher's personality, and encourages individual teacher growth.

Neagley and Evans group supervisory activities into individual techniques and group techniques. Under individual techniques they list:

> (1) assignment of teachers, (2) classroom visitation and observation, (3) classroom experimentation, (4) college courses, (5) conferences (individual), (6) demonstration teaching, (7) evaluation, (8) activities and conferences of professional organizations, (9) professional readings, (10) professional writing, (11) selection of instructional materials, (12) selection of professional staff, (13) supervisory bulletins, (14) informal contacts, and (15) other experiences contributing to personal and professional growth.[34]

Under group techniques they stressed (1) programs for the orientation

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[31] Swearingen, pp. 1-312.

[32] Wiles, p. 17.

[33] John A. Bartky, Supervision as Human Relations (Boston: D. C. Heath and Company, 1953), pp. 1-78.

[34] Neagley and Evans, p. 126.

of new teachers, (2) action research, (3) maintenance of professional libraries, (4) intervisitation, (5) a good student teaching plan, (6) testing programs, (7) new organizational plans such as team teaching, (8) public relations, and (9) in-service education.[35]

Even though the responsibilities of supervisors as indicated by various authors are itemized, and even if authors agree on these items to a large extent, one still does not know the relative importance of items within the list or how the supervisor should perform these tasks. The authors vary greatly as to recommendations in carrying out a supervisory task and to the relative emphasis one should place on the various tasks. Apparently many of these differences of opinion among authors concerns how dynamic or how passive the supervisor ought to be in carrying out his functions. Some authors believe, for example, that supervisors should initiate action while others emphasize that decisions should be made within the group and view the supervisor as a consultant to the group.

The literature provides abundant evidence of this variance. In her book, Franseth stresses the importance of the leadership function of the supervisor and states:

> Today supervision is generally seen as leadership that encourages a continuous involvement of all school personnel in a cooperative attempt to achieve the most effective school program.[36]

Lipham states that the educational leader "is concerned with initiating changes in establishing structures, procedures, or goals; he is

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[35] Ibid., p. 186.

[36] Franseth, p. 19.

disruptive of existing state of affairs".[37] Hicks[38] sees the supervisor in a more passive role such as a consultant, resource person, and co-ordinator. Burnham and King[39] believe the primary role of the supervisor is to foster leadership in others and define the actual role of the supervisor as a composite of all the expectations held for the role by the people associated with it. Brisco[40] emphasized the team approach to supervision and Lessinger[41] emphasized district councils where the supervisor coordinates the efforts of the team or council.

After conducting research on group decisions, Maier indicates that a solution worked out by a group is more acceptable to the group than one imposed on the group by an authority. But he views the supervisor as playing a more dynamic role than that of a coordinator:

> The democratic leadership technique is, therefore, not only a useful procedure for obtaining acceptance and co-operation, but it is also effective for improving solution quality. Even when the leader possesses exceptional ability in solving technical problems, he need not sacrifice this ability in order to maintain group good will. Rather he can learn to conduct conferences in such a manner as to stimulate thinking and thereby have his ideas rediscovered and accepted.[42]

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[37] James M. Lipham, "Leadership and Administration," Behavioral Science and Educational Administration, Sixty-Third Yearbook of the National Society for the Study of Education, Part II (Chicago: University of Chicago Press, 1964), p. 122.

[38] Hicks, p. 20.

[39] Reba M. Burnham and Martha L. King, Supervision in Action (Washington, D. C.: Association for Supervision and Curriculum Development, NEA, 1961), p. 32.

[40] Robin Briscoe, et al., "A Team Approach to Supervision," Educational Leadership, XXI (November, 1963), 84-88.

[41] Leon M. Lessinger, "New Patterns of Supervision: District Councils," Journal of Secondary Education, XXXVIII (December, 1963), 134-137.

[42] Norman R. F. Maier, "The Quality of Group Decisions as Influenced by the Discussion Leader," Human Relations, III (1950), 170.

Some research on leader behavior would suggest more forceful supervisory leadership than is recommended by many authors. For example, in a study comparing student leaders with non-leaders Carter found that the "unique behavior of leaders for all situations and tasks was concerned with (a) analyzing the situation and (b) initiating action required".[43]

The literature regarding supervision contains terms such as creative supervision,[44] team approach, and group process which have not been adequately defined. Much of the confusion concerning the role of the supervisor is due to the use of these terms to describe his behavior. Both Lonsdale[45] and Babcock[46] recognized and discussed this problem. Because of the extensive use of inadequately defined terms, shifts in emphasis in the literature are difficult to detect. But recent literature seems to indicate that the supervisor should exert more forceful leadership than was evident in the past several decades. Cunningham, for example, states:

> Whereas supervision in the past may have been directed at maintaining levels of performance within schools, now the supervisory function includes defining and redefining goals, clarifying personnel relationships, elevating levels of aspiration of people in our schools, assessing the performance of teachers and other staff

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[43] Launor F. Carter, et al., "The Behavior of Leaders and Other Group Members," Journal of Abnormal Social Psychology, XLVI (1951), 595.

[44] John A. Richard, "The Art of Creative Supervision," Educational Leadership XXI (November, 1963), 80-83.

[45] Bernard J. Lonsdale, "The 'Guese' of Supervision," Educational Leadership XXI (November, 1963), 69-74.

[46] Chester D. Babcock, "The Emerging Role of the Curriculum Leader," Role of Supervisor and Curriculum Director in a Climate of Change, The 1965 Yearbook of the Association for Supervision and Curriculum Development (Washington, D. C.: ASCD, 1965), p. 58.

> members and, most important of all, establishing a climate for innovation and change.[47]

Lucio and McNeil have also noted this shift in emphasis in the role of the supervisor:

> A new emphasis is being given the supervisory role. The professional expectation that supervisors will inspire has been amplified, and responsibility for crucial purpose-setting decisions as opposed to routine housekeeping has been made explicit. . . . The new role of the supervisory statesman differs from the human relations specialist's in that the statesman's inspiration does not derive from the processes of group interaction and the vision of a harmonious team, whatever its end may be. On the contrary, the supervisory statesman finds his goal and places his commitment in the clearly defined purpose and character of the school itself, not in narrow, practical aims set in haphazard fashion.[48]

Ramseyer[49] emphasized that the supervisor should perform the functions of analysis, diagnosis, and the initiation of change either in operation or policy.

The change in the emphasis of the leadership function of the supervisor is apparent from a comparison of the 1960 and the 1965 Yearbooks of the Association for Supervision and Curriculum Development. The 1960 ASCD Yearbook states:

> Leadership is a product of interaction that takes place among individuals in a group and not of the status or position of these individuals. . . . The effectiveness of leader behavior is measured in terms of mutuality of goals, productivity in the achievement of these goals, and the maintenance of group solidarity.[50]

Certainly this is a more passive supervisory role than described in the

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[47] Luvern L. Cunningham, "Effecting Change Through Leadership," Educational Leadership, XXI (November, 1963), 75.

[48] Lucio and McNeil, pp. 37-38.

[49] John A. Ramseyer, "Supervisory Personnel," Preparation Programs for School Administrators, ed. Donald J. Leu and Herbert C. Rudman (East Lansing: Michigan State University, 1963) p. 168.

[50] Leadership for Improving Instruction, The 1960 Yearbook of the Association for Supervision and Curriculum Development (Washington, D. C.: ASCD, 1960), p. 182.

1965 ASCD Yearbook.

> Analyses of the functions of the curriculum leader make quite central his role as an inducer or coordinator of change. The designation "change agent," perhaps more than any other, reflects this key responsibility.[51]

One advantage of the term change agent is that it has been defined. According to Rogers, "a change agent is a professional person who attempts to influence adoption decisions in a direction that he feels is desirable".[52]

Cain[53] conducted a questionnaire study of elementary supervisors, principals, and teachers to analyze the functions of the general elementary school supervisor. He concluded that the morale and professional growth functions are considered to be highly desirable and elementary school supervisors are generally perceived as performing them. In addition, he found evidence of confused perceptions in the area of morale, school community relations, assistance, professional growth and administration.

Hallberg analyzed the expected and actual behaviors of general elementary supervisors by conducting a questionnaire study involving supervisors, superintendents, principals, and teachers. Among her findings, the supervisory behaviors considered to be of highest value by all four professional groups were:

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[51] Paul R. Klohr, "Looking Ahead in a Climate of Change," Role of Supervisor and Curriculum Director in a Climate of Change, The 1965 Yearbook of the Association for Supervision and Curriculum Development (Washington, D. C.: ASCD, 1965), p. 150.

[52] Everett M. Rogers, Diffusion of Innovation (New York: The Free Press of Glencoe London: Macmillan New York, 1962), p. 254.

[53] Gerald Gene Cain, "An Analysis of the Functions of General Elementary School Supervisors in the Public Schools of Missouri," Dissertation Abstracts, XXV, No. 10 (1965), 5671.

22.* gives support to teachers who are willing to try out new techniques in instructional materials and teaching.

20. calls attention of teachers and principals to new and worthwhile professional literature.

9. serves as a member of working committees when invited.

57. strives to secure good working conditions for staff members.

51. helps all personnel to have faith in themselves.

45. recognizes individual differences in staff personnel.

39. strives to build working rapport between himself and the professional staff.

33. helps to maintain ethical standards of the profession.

42. takes an active role in local professional organizations.

48. serves on state-wide committees sponsored by the State Department of Education, when invited.

58. reads professional literature regularly.

35. evaluates the objectives of the curriculum.[54]

* These numbers are those used on Hallberg's questionnaire.

Hallberg concluded that:

> The supervisory role is expected to emphasize the human relations aspect and the supervisors are perceived as fulfilling this expectation. . . . supervisors in Oregon are behaving in a passive manner rather than showing forceful leadership. This action agrees in general with the behavior expectations held for supervisors.[55]

Lott[56] studied the ideal and actual behaviors of supervisors by collecting data from elementary teachers, secondary teachers, elementary

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[54] Hazel Irene Hallberg, "Analysis of the Expected and Actual Behaviors of Supervisors in the Role Concept of Four Professional Groups" (unpublished Ed.D. dissertation, College of Education, University of Oregon, 1960), pp. 64-65.

[55] *Ibid.*, p. 112.

[56] Jurelle Gilmore Lott, "A Statistical Study of the Concepts of the Role of the Instructional Supervisor" (unpublished Ed.D. dissertation, College of Education, University of Georgia, 1963), p. 161.

principals, secondary principals, supervisors, and superintendents. A statistical analysis of data revealed differences between the perceptions of both ideal and actual behaviors of the supervisor in each of the six groups.

Both Hallberg and Lott found differences among role definers as to how passive or dynamic supervisory leadership ought to be. For example,

> Classification of items in terms of their content indicates that conflicting conceptions of role were essentially conflicts over expertness and managerial ability versus permissiveness and group dynamics concepts of supervision.[57]

Summary

The literature dealing with general supervision indicates:

1. the growing concern for the clarification of the role of the supervisor,
2. the responsibilities of the supervisor are numerous, varied and complex, and
3. the recommended supervisory activities are apparently related to curriculum, leadership, in-service programs, self-growth, public relations, selection and use of materials, evaluation, and research.

Apparently, most of the confusion as to the role of the supervisor is related to how dynamic or how passive his leadership function is or should be. Further, there seems to be a trend in the literature describing a more dynamic leadership function than a decade ago. This trend is evidenced by recent descriptions of the supervisor as a

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[57]Jurelle Gilmore Lott, "A Statistical Study of the Concepts of the Instructional Supervisor," Dissertation Abstracts, XXV (1963), 2324.

statesman or a change agent.

Objectives of Science Education

The objectives of science education were developed in this study to serve as a basis for items in Part I of the questionnaire. Part I was designed to determine whether the views of science supervisors and teachers differed concerning the relative importance of the characteristics of science curriculum materials and of the objectives of science education in selecting science curriculum materials. Because these items are related to materials resulting from curriculum development projects, it is desirable to relate the objectives of science education to curriculum development.

The Importance of Specifying Objectives

The great majority of the writings on curriculum development stress the importance of establishing educational objectives. Tyler, for example, states:

> . . . if an educational program is to be planned and if efforts for continued improvement are to be made, it is very necessary to have some conception of the goals that are being aimed at. These educational objectives become the criteria by which materials are selected, content is outlined, instructional procedures are developed and tests and examinations are prepared.[58]

Although many authors agree that educational objectives should be specified, far fewer agree on who should specify these objectives. This determination is a basic and most controversial issue in education today. A few people have attempted to clarify positions and make recommendations regarding the development of objectives. One example is the

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[58]Ralph W. Tyler, Basic Principles of Curriculum and Instruction (Chicago: The University of Chicago Press, 1950), p. 3.

NEA Project on the Instruction, Recommendation 20:

> The aims of education should serve as a guide for making decisions about curriculum organization as well as about all other aspects of the instructional program.
>
> The public, through the local school board, is responsible for determining the broad aims of education. The professional staff is responsible for translating the broad aims into specific objectives that indicate priorities and define clearly the behaviors intended for the learners. The local board of education has responsibility for seeing that an acceptable statement of objectives and priorities is prepared and for endorsing such a statement.[59]

While this statement does not clearly limit the lay public's responsibility for establishing objectives, it does place on the professional staff the responsibility of translating the broad aims of education into specific behavioral objectives and most authors agree that objectives should be stated in behavioral terms. In these terms an objective is a statement of the kind of behavior pattern which the school seeks to have the student develop.[60]

Educational objectives must be established as they are an integral part of curriculum development. But what are their sources? How can they be established? Objectives can be determined by analyzing:

1. Culture and its needs
2. The learner and learning process, and principles
3. Areas of human knowledge and their unique functions
4. Democratic ideals.[61]

Cohen[62] has concluded that educational objectives can be derived from

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[59] John I. Goodlad, Planning and Organizing for Teaching (Washington, D. C.: National Educational Association, 1963), p. 50.

[60] Tyler, p. 4.

[61] Hilda Taba, Curriculum Development: Theory and Practice (New York: Harcourt, Brace and World, Inc., 1962), p. 438.

[62] David Cohen, "An Australian Science Curriculum Model" (unpublished Ph.D. dissertation, College of Education, Michigan State University), p. 258.

studies in philosophy, sociology, and psychology. Tyler elaborated on sources of objectives such as studies of the learner, studies of contemporary life outside of school, the specific subject area, and philosophy.[63] A summary of the sources of educational objectives would include the society or culture, the nature of the learner and of learning, philosophy and/or a system of values, and organized knowledge.

Since the historical development of educational objectives in the United States has been traced many times (e.g., by Cohen), this work need not be repeated. It is sufficient to state that such studies reveal that the sources of educational objectives change, or our knowledge concerning these sources change. Many factors recently have caused a rapid change in these sources. Modern science and technology, economic growth, urbanization, and population growth are a few of these factors. Because educational objectives reflect the changes in their sources, objectives too change rapidly. Hence,this study uses the most recent statement of educational objectives resulting from a thorough and complete study of these sources, namely,the NEA Project on the Instruction.

> The essential objectives of education, therefore, must be premised on a recognition that education is a process of changing behavior and that a changing society requires the capacity for self-teaching and self-adaptation. Priorities in educational objectives should be placed upon such ends as:
>
> *learning how to learn, how to attack new problems, how to acquire new knowledge
> *using rational processes
> *building competence in basic skills
> *developing intellectual and vocational competence
> *exploring values in new experience
> *understanding concepts and generalizations[64]

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[63] Tyler, pp. 4-40.

[64] Robert J. Havighurst, et al., Schools for the Sixties, A Report on the Project on Instruction, National Educational Association (New York: McGraw-Hill Book Company, 1963), p. 9.

Objectives of the Specific Subject Areas

Since the objectives of education can be determined from studies in fields such as sociology, psychology, and philosophy, these same fields together with the logical structure of the discipline from the specific subject area can be used to derive the objectives for that particular subject area. Much of the literature published since 1960 supports this position.

> I was taught to believe that curriculum arose from two fields: The nature of the growing child, and the nature of society. . . . What was left out of this theory was the nature of organized knowledge.[65]

This structure consists of the relationships among important concepts within a discipline.[66] Bruner and others apparently have had considerable influence in causing educators to examine the structure of the particular discipline in curriculum development. For example:

> To recapitulate, the main theme of this chapter has been that curriculum of a subject should be determined by the most fundamental understandings that can be achieved of the underlying principles that give structure to that subject.[67]

Recent materials published by the NEA indicate a similar emphasis.[68] Taba summarized the situation:

> Therefore, scientific curriculum development needs to draw upon analyses of society and culture, studies of the learner and the learning process, and analyses of the nature of knowledge in

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[65] Arthur W. Foshay, "A Modest Proposal for the Improvement of Education" cited in What are the Sources of the Curriculum? A Symposium (Washington, D. C.: Association for Supervision and Curriculum Development, 1962), pp. 2-3.

[66] Jerome S. Bruner, The Process of Education (New York: Vintage Books, 1963), p. 6-8.

[67] Ibid., p. 31.

[68] Dorothy M. Fraser, et al., Deciding What to Teach (Washington, D. C.: National Educational Association, 1963), pp. 21-22.

order to determine the purposes of the school and the nature of its curriculum.[69]

According to what has been said thus far, one could logically conclude that it is possible and valid to derive the objectives of science education from the objectives of education in general and the nature of science. Hence, for this study the objectives of science education will be derived from the educational objectives as developed by the NEA Project on the Instruction and the nature of science as specified in this chapter.

The Nature of Science

The various definitions of science provide some insight into the nature of science. These definitions clearly have elements in common:

> In short, science is what scientists do, and there are as many scientific methods as there are individual scientists.[70]

> Science . . . is a point of view that insists on a rational explanation, based on experience, of the data of external world . . . .[71]

> There are two forms or aspects of science. First, science is a body of useful and practical knowledge and a method of obtaining it. . . . second . . . science . . . is a pure intellectual study.[72]

> Science is an interconnected series of concepts and conceptual schemes that have developed as a result of experimentation and observation and are fruitful of further experimentation and

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[69] Taba, p. 10.

[70] Paul Brandwein, Fletcher Watson, and Paul Blackwood, Teaching High School Science: A Book of Methods (New York: Harcourt, Brace & World, Inc., 1958), p. 13.

[71] I. Bernard Cohen, Science, Servant of Man (New York: Little, Brown and Company, 1948), p. 51.

[72] Norman Campbell, What is Science? (New York: Dover Publications, Inc., 1948), p. 1.

observations.[73]

> Science is a process in which observations and their interpretations are used to develop new concepts, to extend our understanding of the world, to suggest new areas for exploration, and to provide some predictions about the future. It is focused upon inquiry and subsequent action.[74]

> We defined the scientific method by the cycle of induction, deduction, and by its eternal search for improvement of theories which are only tentatively held. . . . we can use the definition in turn to define "Science".[75]

Among these common elements is direct observation or observation through experimentation. Simpson, in fact, considered observation an essential component of any definition of science:

> Definitions of science may differ in other respects, but to have any validity they must include this point: the basis of science is observation.[76]

A second element common to definitions of science may be referred to as the thought processes involved in the scientific methods or scientific inquiry. A scientist does not stop with simple observations; he organizes and interrelates the facts gathered from observations to form abstract generalizations or concepts. The interrelation of these concepts give rise to the theoretical structure through which predictions can be made.

Both the definitions of science and the activities of scientists,

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[73] James B. Conant, Science and Common Sense (New Haven: Yale University Press, 1951), p. 25.

[74] Paul DeHurd, "Science Education for Changing Times," Rethinking Science Education, Fifty-Ninth Yearbook of the National Society for the Study of Education (Chicago: University of Chicago Press, 1960), p. 35.

[75] John G. Kemeny, A Philosopher Looks at Science (New York: D. Van Nostrand Company, 1959), p. 176.

[76] George Gaylard Simpson, "Biology and the Nature of Science," Science, CXXXIX (January, 1963), 81.

therefore, indicate that science has two aspects: the rational and the empirical.

> . . . the marriage of the logical with the empirical method. . . . This union of two methods is the very basis of science.[77]

> Certainly, neither experimentation nor mathematics had to wait for birth until the flowering of Western science. Nevertheless, in this flowering something of undeniable importance took place: the incorporation of mathematics and experimentation within a single method.[78]

Science combines empirical methods with rational methods to seek a system that permits predictions. In the empirical method knowledge is derived from experience, which might be simple observation or observation by elaborate instrumentation. In the rational method knowledge is secured through thought processes without reference to direct experience.

Empirical knowledge by its very nature is inconclusive because it is impossible to observe all possible cases. Since all scientific conclusions are formed with inadequate data, they must be considered tentative. Revision of scientific conclusions as additional data are collected is to be expected and must be considered part of the process of science.

Let us consider the basic metaphysical assumptions of science: knowledge can be established by observation and experimentation; there is order or regularity in the universe.[79] Other assumptions frequently associated with the nature of science arise from the confusion of science

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[77] J. Bronowski, The Common Sense of Science (Cambridge: Harvard University Press, 1958), p. 29-30.

[78] Charles W. Morris, "Scientific Empiricism," International Encyclopedia of Unified Science, I (Chicago: University of Chicago Press, 1938), 63-64.

[79] Cecil J. Schneer, The Search for Order (New York: Harcourt, Brace and World, Inc., 1961), p. 13.

and common sense. To understand the nature of science, therefore, it is essential to contrast and compare science and common sense.

One of the many metaphysical assumptions of common sense is that a consensus of opinion makes a statement true. If one assumes that knowledge is based on the experience of the population as a whole, then this common knowledge is the common sense of that population. But these experiences differ from experiences in science in that the observations are usually not systematic and are not derived through the elaborate use of instruments, and even when experiences of scientists and the general population are similar, the languages used to express ideas and relations differ sharply.

> The use of language in science is specialized and particular. . . . The range and exactitude of scientific prediction exceed any cleverness of everyday life: the scientist's use of language is strangely effective and powerful.[80]

The language of the general population lacks this precision. ". . . the language in which common-sense knowledge is formulated and transmitted may exhibit two important kinds of indeterminancy"[81] in that terms in ordinary speech are quite vague and they lack a relevant degree of specificity compared to the language of science.

History reveals that common sense understandings and assumptions are changed by scientific discoveries, but since this usually occurs only after the knowledge produced by the discoveries is applied to technology, common sense usually takes a long time to incorporate them. For example, Leeuwenhoek's discovery of bacteria in 1683 had little

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[80] Leonard Bloomfield, "Linguistic Aspects of Science," International Encyclopedia of Unified Science, I (Chicago: University of Chicago Press, 1938), 219.

[81] Ernest Nagel, The Structure of Science (New York: Harcourt, Brace and World, Inc., 1961), p. 8.

influence on common sense for nearly 100 years. Then Pasteur and others demonstrated the relation between bacteria and disease which catalyzed the change. Although common sense has no recorded history, we cannot suppose that it has no development. Common sense has developed, but more slowly than science.[82]

The magnitude of this time lag seems to depend upon how rapidly scientific knowledge increases and how uniform the population experiences are. In order to illustrate these relations, Punke[83] emphasized that primitive societies or isolated communities differ from our modern society in two ways: (1) cultural change was relatively slow, and (2) population groups were small and each group was rather closely knit. As a result, most of the knowledge possessed by any tribe member became the common knowledge or common sense of the primitive society. Because of the rapid increase of knowledge today, much of the scientific knowledge is possessed by few people compared to the relative ignorance of the general population. This produces a wide gap between science and common sense.

Science and common sense, then, show fundamental differences. The Michelson-Morley Experiment (1888) for example, forced scientists to conclude that the Galileo-Newtonian relativity was not correct. Then, in 1905, Einstein concluded that there is no preferred coordinate system and that the velocity of light is the same for all observers. These conclusions gave rise to Einstein's theories of relativity.

> There are two aspects of Einstein's handling of the physical concepts. There is, in the first place, a realization that the

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[82]Bronowski, p. 12.

[83]Harold H. Punke, "Science, Philosophy, Common Sense--and the American High School," Science Education, XLII (December, 1958), 410.

> paradoxes involved primarily questions of meaning and that the common-sense meaning of such terms as length and time were not sharp enough to serve in the situation presented by the new facts. In the second place, there was the method by which the necessary increase in sharpness was imparted to the meaning. . . . Einstein insisted that we do not know what we mean unless we can give some concrete procedure by which we may determine whether or not any two specific events are simultaneous.[84]

Einstein's theories of relativity provide jokes for the man on the street because they are contrary to common sense assumptions. To illustrate this:

> What does the relativist mean when he states that a velocity of 170,000 miles per second added to a velocity of 170,000 miles per second gives a velocity of 185,000 miles per second?[85]

A more drastic disparity between science and common sense can be seen through a study of quantum physics. Many discoveries in this field indicate clearly that scientists must distinguish between common sense assumptions and facts in forming theories to explain physical phenomena. For example, one of the basic common sense assumptions of classical or nineteenth century physics was that continuity (as opposed to discontinuity or discreteness) is the fundamental and necessary feature of all physical reality. Hence, it was applied to all of the fundamental processes of physical reality such as heat, light, and electromagnetism. But this assumption was proven fundamentally wrong. Spectroscopic analysis of the radiation from heated bodies illustrates this because it led to data that could not be reconciled by the continuous theory of radiation. After studying this problem, Max Planck concluded that radiation is not continuous; instead, it is discontinuous and consists

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[84] P. W. Bridgman, "Science and Common Sense," Etc.: A Review of General Semantics, XII (Summer, 1955), 265-266.

[85] Arnold B. Arons and Alfred M. Bork, Science and Ideas: Selected Readings (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1964), p. 12.

of small, discrete bundles of energy which he called quanta.

Soon other experiments were explained in terms of this new theory. In 1905 Einstein used Planck's theory to explain the photoelectric effect, which could not be explained in terms of continuous wave theory. When light was viewed as a stream of discrete pieces which Einstein called photons, the phenomena became quite simple to explain in a way that was completely consistent with the experimental data.

> Planck's new "quantum theory" . . . was perhaps the single most revolutionary idea yet advanced in the history of physics and it was completely opposed to "common sense" ideas about the nature of physical reality.[86]

As small particle study continued, other common sense assumptions were shown to be not only unnecessary to science, but a hazard to scientific thinking. For example, the assumption that the observer and the observed are completely separate was shown to be false through small particle study. Any experiment devised to look at an electron will change the position and velocity of that electron. Increasing the precision of the instruments will not overcome this difficulty because according to Heisenberg's Uncertainty Principle one can never obtain exact knowledge of the momentum and position of an object, regardless of the improvements in experimental techniques. Perhaps an analogy will illustrate how contrary this is to common sense assumptions. A certain ball accelerates rapidly when struck by light. If this ball were in a perfectly dark room, could you locate it with a flashlight?

> We are coming to recognize that it is a simple matter of observation that the observer is part of what he observes and that the thinker is part of what he thinks.[87]

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[86] James L. Slattery, "The Explosion in Physics, Part II," The Kiwanis Magazine, XLVIII (February, 1963), 36.

[87] Bridgman, 274.

The work of de Broglie, Born, Dirac, Schrödinger, and others demonstrates that the above examples are not exceptions to the rule but the rule itself. Relativity and quantum theory have illustrated that the common sense assumptions of classical physics are only rough approximations even when considering large objects at low velocities. In fact, discoveries contrary to many common sense assumptions are not unique to physics, but seem to characterize science discoveries in general. It is significant that Taton reached a similar conclusion after studying early experimentation in astronomy, biology, and physics.

> In effect, these discoveries involved a complete break with apparently very solidly established opinions, with the most common preconceived ideas, and with theories considered as evident by common sense.[88]

The difference between science and common sense has been extensively illustrated because the conclusions one draws concerning the relation of science and common sense directly affects the implications for education.

> . . . we . . . cannot regard a man as well educated who does not intuitively recognize that common sense is not to be taken for granted, or who does not handle his thinking as a tool in the awareness that every tool has limitations built into it.[89]

If the basis of both common sense and science is experience or observation, why should there be such striking differences between scientific findings and common sense conclusions? The answer to this question brings one to the heart of science--verification.

A scientist begins with observation and the gathering of facts. A fact is a verifiable observation. By organizing facts he may recognize

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[88] R. Taton, Reason and Chance in Scientific Discovery (New York: The Philosophical Library, Inc., 1957), p. 147.

[89] Bridgman, 277.

patterns or relations among the facts. If he does recognize relations among the facts, he ponders possible explanations for these relations. To determine which of the possible explanations or theories is most likely to be correct, he predicts facts x, y, z that would logically follow assuming theory A to be true. He then designs experiments based on theory A so that facts x, y, z can be observed. If his experiments confirm his predictions about x, y, z, then these facts tend to support theory A. But since it is possible to predict an infinite number of facts from theory A, it is impossible to prove definitely theory A. So its validity must be held only tentatively. If scientists can continue to predict facts from theory A that are consistent with known facts or are verified by experiment, the theory is useful and they continue to develop it.

> The key to the verification of theories is that you never verify them. What you do verify are logical consequences of the theory. Verification is the process of seeing whether something predicted is really so. Since we can only observe particular facts, we must verify particular consequences of a theory, not the general theory itself.[90]

Scientists use inductive reasoning in forming theories to explain observed facts; they use deductive reasoning in predicting facts from a theory.

> . . . logical deduction is no more than the analysis of the meaning of theory. When we say that these facts follow, we mean that their truth is contained in the truth of the theory . . . .[90]

Since inductive and deductive reasoning are essential to science, science is said to be rational.

To comprehend the nature of science one must also understand its cyclic nature. From observations or facts, scientists generate theories;

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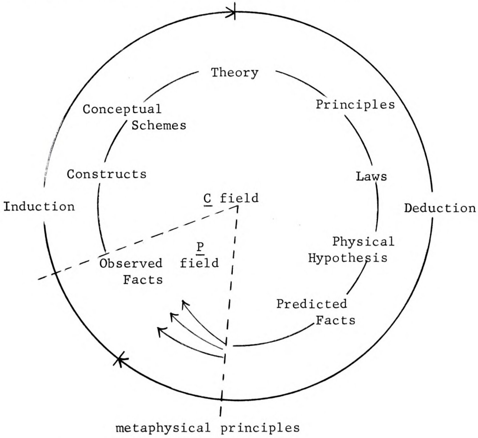
[90]Kemeny, p. 96.

they use those theories to make predictions; they experiment to test these predictions against facts; and they then use these facts to generate other theories.

> As Einstein has repeatedly emphasized, Science must start with facts and end with facts, no matter what theoretical structures it builds in between. First of all the scientist is an observer. Next he tries to describe in complete generality what he saw, and what he expects to see in the future. Next he makes predictions on the basis of his theories, which he checks against facts again.
>
> The most characteristic feature of the method is its cyclic nature. It starts with facts, ends in facts, and the facts ending one cycle are the beginning of the next cycle.[91]

Robinson in a paper presented to the 1965 Convention of the National Association for Research in Science Teaching used the following diagram to illustrate this cycle or circle of thought.



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[91] Ibid., pp. 85-86.

> This circle of thought "begins," "ends," and "continues" in the area of observation and thus emphasizes the empirical roots of the physical sciences. But observations are not given in nature. They are selected by the scientist--selected against the background of contemporary theory, general and metaphysical principles, and pragmatic considerations.[92]

The P field designates the level of sense observation; the C field designates the area of verbal description or the conceptual area.[92]

The basis of both science and common sense is observation, but science has methods for verifying knowledge; common sense does not. This monumental difference enables science to generate knowledge much faster than common sense. As a result science surges ahead while common sense lags behind.

The history of science provides evidence that the various sciences began with observation and as they developed, they moved toward a theoretical or exact level, less related to common sense.[93] As science becomes more highly developed, often the empirical data do not make sense--that is, the facts are contrary to common sense and scientists are forced to relate the empirical facts by using symbolic logic (mathematics) to build hypothetical constructs. Hence, as a field of science develops, it becomes more abstract and highly mathematical. This process was stated clearly by Hill.

> One of the most striking aspects of the development of physical theory during the last two centuries has been the growing use of mathematical symbolism as a medium for the expression of ideas. Logical deduction, in its traditional form of verbal or printed argumentation, is being supplanted to an astonishing degree among scientists by the more rigid and impersonal methods of mathematical

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[92] James T. Robinson, Science Teaching and The Nature of Science, A Report to the National Association for Research in Science Teaching Convention, Chicago, February 13 to 15, 1965 (Chicago: The Convention, 1965), p. 11. (Mimeographed.)

[93] Philipp Frank, Philosophy of Science (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1957), p. 44.

analysis. While this trend has developed to the greatest extent in the fields of physics and engineering, where it has proved to be indispensable, scientific disciplines of all kinds are commonly judged to have become more fundamental in proportion as they make an increasing use of formal mathematics. The intellectual implications of this movement should be of the liveliest interest to the philosopher of science.

Mathematics, at least in the hands of people who are not professional mathematicians, usually has a double significance, being at once a symbolic language and a compact form of logic.[94]

Though science and common sense differ, they reinforce each other. As was stated earlier, they both start with observation and in a very young science they are closely related. It is clear from the history of science that much of science began because of problems from the environment or apparent inconsistencies in the environment. In other words, science started where the environment differed with the common sense of the day. Although science does surge ahead of common sense, this is not to say that common sense does not change. A strong case can be presented, using for example the control of disease and the control of energy, to indicate that common sense is changed by science and technology. To understand the relation of science and common sense, however, it is necessary to see how both relate to philosophy. Frank states:

> Science starts from common sense, and from generalization by induction or imagination one derives science; but the derived principles themselves may be very far from common sense. To connect these principles directly with common sense--this is the work done by philosophers.[95]

Frank illustrates these relations by a diagram:

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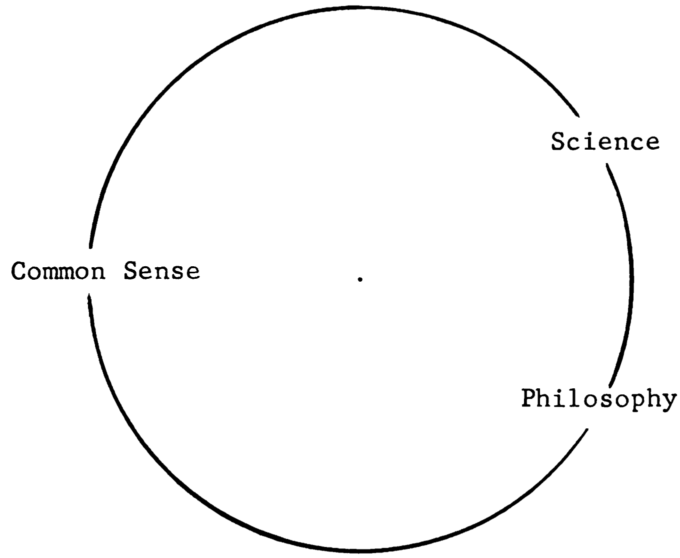
[94]E. L. Hill, "Quantum Physics and The Relativity Theory," Current Issues in the Philosophy of Science, ed. Herbert Feigl and Grover Maxwell (New York: Holt, Rinehart and Winston, 1961), p. 429.

[95]Frank, pp. 46-47.



This diagram illustrates that one can go from science to common sense in two ways:

1. The scientific way which involves empirical and rational methods. Essentially this means that a majority of the population would have to become familiar with the methods of scientific inquiry, acquire the attitudes necessary for successful inquiry and comprehend sufficient concepts of science to relate them to everyday living.

2. The philosophical way which involves relating scientific findings to common sense through philosophical interpretation.

If we wish to reduce the gap between science and common sense, Frank diagramed two possible routes, but because of the intimate relation of science, philosophy, and common sense, selecting one route is out of the question; we must incorporate both.

Science influences common sense through technology. But to develop technology we begin with science and apply it to the solution of practical problems. Since science must precede technology, the change in common sense due to technology will lag considerably behind science. Therefore, in order to bridge the gap between science and common sense, we must look also to the second facet--philosophy.

It is possible for philosophy and science to influence common sense through science education. As was stated earlier in this chapter, science education objectives are established through studies of the learner, the society, philosophy, and the nature of science. The establishment and fulfillment of science education objectives, therefore, becomes a way of using both routes to change common knowledge of science. If the objectives of science education reflect the nature of science and contemporary science and if these objectives are fulfilled by the teaching and learning of science in the nation's classrooms, then the knowledge of science that is common to the population increases considerably. One of the greatest challenges of our times is, then, to bridge the gap between science and common sense through science education.

Educational Objectives, Nature of Science and Objectives of Science Education

Earlier in this chapter, the validity of deriving the objectives of science education from educational objectives as developed by the NEA Project on Instruction and the nature of science was shown. Having just considered the nature of science, the objectives of science education which served as the basis of Part I of the questionnaire can now be derived.

Let us consider the first two educational objectives and relate them to the appropriate elements from the nature of science.

> *learning how to learn, how to attack new problems, how to acquire new knowledge
> *using rational processes[96]

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[96]Havighurst, et al., p. 9.

When one considers the above objectives in terms of the specific area of science education, one realizes that they involve the elements of scientific inquiry. The two elements that are deeply involved in scientific inquiry and are common to many definitions of science are the empirical and rational methods of inquiry. The empirical methods would include all observation with or without the aid of instrumentation. The rational methods would include the inductive and deductive reasoning processes as described earlier in this chapter.

If science education is to reflect the nature of science and scientific inquiry, then one would expect emphasis on the empirical or the experimental methods. In fact experimentation would become the primary source of learning. Emphasis would be placed on methods of inquiry including rational methods as well as empirical methods: how to collect, organize and observe relations in data; how to use symbolic logic to build hypothetical constructs, predict facts based on these constructs, and generate hypotheses and design experiments to test the hypotheses to see if the predicted facts are verified. Emphasis would also be placed on the tentative nature of scientific conclusions by using methods of inquiry to make and revise conclusions. Since it is possible to obtain supporting evidence for conclusions and not proof, others interested in the experiment must be able to replicate it. Science education, therefore, should emphasize communication to the extent that experiments are accurately described and data displayed so that others can replicate the experiment if they desire.

If all of the above factors are considered, then the student in science education would be expected to acquire the following understandings and behaviors:

I. Observation and Rational Processes

A. Observation

1. Observe those things that are relevant to the problem at hand

2. Understand the relationship of observation and theory--without theory one does not know what to observe

3. Design experiments so that desired observations can be made

4. Understand the influence of the observer on what is being observed

5. Use instruments properly to aid in observation and understand the role of instruments in science

6. Quantify observations and organize data so that they are meaningful.

B. Rational Processes

1. Understand the distinction between inductive and deductive aspects of theory

2. Organize data in such a way that patterns can be observed and valid conclusions can be drawn

3. Form hypothetical constructs to explain patterns and relations within data

4. Operationally define terms and concepts; understand the impossibility of divorcing concepts from the operations through which they are generated

5. Predict phenomena from hypothetical constructs and design experiments to verify these phenomena and generate facts

6. Treat scientific data and conclusions in such a way that an understanding of the tentative nature of the scientific

conclusions is evident

7. Understand the cyclic nature of science

8. Understand when experimental conclusions are valid

9. Express thoughts in some system of symbolic logic such as mathematics in order to validate the reasoning.

II. Metaphysical Assumptions

A. All science is based on two metaphysical assumptions: knowledge can be established by observation and experimentation; there is order or regularity in the universe.

B. If science education is to reflect these metaphysical assumptions, then one would expect the science student to acquire the following understandings and behaviors:

1. Understand the role of metaphysical assumptions in directing inquiry

2. Understand the limitations as well as the strengths of the methods of science

3. Understand the relation between the assumption of regularity in the universe and prediction

4. Understand the role of man as an interpreter of nature; consequently, the study of language is essential to a scientist.

III. Relation of Common Sense, Science, and Science Education

When one considers the competencies and skills needed for successful citizenship in a technological society, then the relationship between this topic and two additional educational objectives developed by the NEA Project on Instruction becomes apparent.

*building competence in basic skills
*developing intellectual and vocational competence[97]

If one assumes that historically common sense has been changed by scientific technology and that it is desirable to reduce the gap between science and common sense, then science education is obligated to narrowing this gap. It may be no surprise to find that the type of science education already outlined would also be the kind most likely to narrow this gap because students of the general population would be taught to think more like contemporary scientists. Science education cannot be static, but must be as dynamic and rapid changing as science itself. Hence, the success in narrowing the gap between science and common sense will depend upon how accurately science education reflects contemporary science and how rapidly science itself changes.

If the confusion of common sense ideas with knowledge derived by empirical methods has retarded the development of science and scientific technology, then science education should clearly distinguish between the two and teach students to deal logically with empirical data even when it is contrary to common sense assumptions. Students should be taught to deal with abstract ideas, to rely on logic instead of common sense in drawing conclusions. In this way science education would be similar to mathematics education.

A. Science and Common Sense

1. Common sense is based upon the experiences that the members of the population have in common. Science observations are usually made through the use of elaborate instrumentation

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[97] Ibid., p. 9.

and these are not common to the population.

2. The language used to transmit science is much different than the language used to transmit common sense.

3. Science is based upon systematic observation and rational processes; common sense is based upon consensus of opinion.

B. Science Education

If science education is to reflect the relation of common sense and science, then one would expect science students to acquire the following understandings and behaviors:

1. Deal logically with abstract ideas of science even when they are contrary to common sense ideas

2. Exhibit a difference in their attitudes toward scientific findings and common sense information

3. Generate data by experimental procedures and think in terms of that data without interference from common sense notions

4. Understand that common sense lags behind science and that there is not necessarily a conflict between them

5. Does not take common sense notions for granted, but questions and tests them by scientific methods.

IV. Development of Science

A. As a science develops it becomes more quantitative, more theoretical, more exact, and makes increasing use of mathematical systems. Various fields of science are at various stages of development, but the thrust of all sciences has been toward exact or theoretical procedures.

B. Accordingly, the understandings and behaviors one would expect students to acquire through science education:

1. Increasingly be able to collect, organize, and see relations in data; to use symbolic logic to build hypothetical constructs; generalize, hypothesize, and design experiments to test these hypotheses
2. Increasingly understand the development of a science
3. Increasingly understand the logical, mathematical, and syntactical structure of science.

V. Scientific Discovery and the Structure of Science

Although scientific discovery and the structure of science are an integral part of the cyclic nature of science, they are isolated here because of their relation to the last two educational objectives by the NEA Project on the Instruction.

*exploring values in new experience
*understanding concepts and generalizations[98]

A. Scientific Discovery

Discovery is part of the methodology of the sciences and does not rely on chance alone. According to most authors on the nature of science, it is the fruit of imagination through a well-prepared mind. Although chance has played a part in many discoveries, they were made by keen observation and the ability to see relationships previously unseen. Discovery, then, does involve chance, but it also involves intuition, creativity, and the ability to use the methods of scientific inquiry.

If science education is to reflect scientific discovery, then the science student would acquire the following understandings and behaviors:

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[98] Ibid., p. 9.

1. Understand the relation of creativity, imagination, intuition, and methods of science to scientific discovery
2. Understand the relation between scientific discovery and the well-prepared mind
3. Understand that most scientific discoveries have taken place only after hard work
4. Understand that the elements of scientific methods are prerequisite skills to discovery
5. Skill in using the elements of scientific methods
6. Skill in designing and conducting exploratory experiments to acquire knowledge.

B. Structure of Science

The structure of a discipline consists of the relatively few, but powerful, concepts and principles that hold the discipline together. These concepts and principles help the student make an entity of his own out of what otherwise is just a collection of isolated facts. Because the volume of scientific knowledge is so great, it is impossible to teach a child all the scientific facts and technology that he will need during his life. It is increasingly necessary, therefore, to teach him those concepts that are essential to the logic and the structure of science itself. Hence, science education must reflect accurately the structure of science.

If science education is to reflect the structure of science, then the student in science would acquire the following understandings and behaviors:

1. Understand the distinction between the structure and the

development of science

2. Understand the distinctions among structure, concepts, and facts

3. Understand the relation of physical concepts to the operations by which they were generated

4. Understand sufficient facts, concepts, and principles in at least one field of science to see the underlying structure of the discipline

5. Understand the relation of validity and the theoretical structure of science

6. Understand the relation of hypotheses and the theoretical structure of science.

Role of the Science Supervisor

The current literature on general supervision, special supervision, and science supervision together with the objectives of science education as developed in this chapter served as valuable background for developing questionnaire items related to the role of the science supervisor in selecting and implementing science curriculum materials. The literature also indicates some differences in emphases between general and special supervision.

Special Supervisor

The term special supervisor appeared in the literature after 1870 to describe those persons employed to help teachers and administrators implement the new subjects, including music, drawing, manual training, and home economics. The meaning of this term in the current literature has been extended to include supervisors in any subject discipline such as English, social science, mathematics, and science. Most authors deal with elementary or secondary supervision or supervision in general and give little or no emphasis to special supervision. Then, too, authors who mention special supervision disagree as to its value. Some authors imply that special supervision is against the principles of democratic leadership.

> The concept of democratic supervision based upon cooperative relationships in the total school program makes it more and more evident that specialized supervision should give way to general supervision.[99]

Other authors take quite an opposing view:

> Supervisors of specialized subject matter, such as art, music, and physical education, have an even more important job to do in implementing the philosophy and objectives of a school than does the general supervisor . . . . They can be expected to render more specific help in curriculum and instruction than the general supervisor.[100]

McKean and Mills maintain that there is no general agreement whether general supervision or special supervision is superior; each has advantages and disadvantages. The general supervisor is able to bring together teachers of various subjects to explore the possibilities of coordination and integration. He seeks to intensify horizontal articulation while the "special supervisor, on the other hand, is more likely to accomplish equally vital progress toward vertical articulation within his subject area."[101]

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[99]Harold P. Adams and Frank G. Dickey, Basic Principles of Supervision (New York: American Book Company, 1953), pp. 15-16.

[100]Robert C. Hammock and Ralph S. Owings, Supervising Instruction in Secondary Schools (New York: McGraw-Hill Book Company, Inc., 1955), p. 81.

[101]Robert C. McKean and H. H. Mills, The Supervisor (Washington, D. C.: The Center for Applied Research in Education, Inc., 1964), p. 22.

Apparently, both the general and the special supervisor have important roles to play in improving the learning and teaching within the school systems. Even those authors who are opposed to special supervision recognize the need for vertical articulation and recommend that the general supervisor secure the help of outside consultants for this purpose.

Many authors agree that "the need for expert assistance in special areas is seldom questioned"[102] and that special supervisors are "guided by the same principles of leadership found useful by other instructional leaders."[102]

McKean and Mills state:

> The special supervisor attached to the central office operates much like a general supervisor except that he tends to be called upon more as a resource in his content speciality rather than his ability to coordinate and facilitate group action. The special supervisor must possess expertness in subject matter in which he specializes and in the methods of teaching it. For example, he may make important contributions in developing vertical articulation . . . .[103]

Apparently the functions of the special supervisor are similar to those recommended for the general supervisor and in addition he is expected to be an expert in his particular subject area, know the methods of teaching unique to that area, and be concerned with vertical articulation. The above statement served as a guide in using the recommended activities of general supervisors to determine items in Part II of this study's questionnaire.

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[102] Jane Franseth, Supervision as Leadership (New York: Row, Peterson and Company, 1961), p. 171.

[103] McKean and Mills, p. 21.

Science Supervisor

For the purposes of this study, science supervisor is used to denote a person to whom responsibility has been delegated for the supervision, leadership, and improvement of the elementary and/or secondary school science program and who devotes a portion of his regular working time to fulfilling this responsibility. Various titles are used for this position such as science consultant, science coordinator, and specialist in science. In reviewing the literature for this section, the investigator assumed that the title is not important so long as the individual adequately fits the above definition.

The current literature indicates that the employment of science supervisors may aid school systems to improve the quality of science teaching; to develop an articulated science program, grades K-6 and/or 7-12; to develop an adequate in-service teacher training program; and to select from the abundant commercial and NSF sponsored science curriculum materials and to aid teachers in implementing these materials to improve the science program.[104] Stotler, after considering the problem in science education and the role of the science supervisor in aiding in their solution, stated:

> In this period of increasing emphasis upon science education, it is imperative that small city and suburban systems provide adequate science supervisory service. It is a prime factor in the improvement of science instruction.
>
> Wherever feasible, a full-time science consultant should be employed to assist with the program in Grades I through XII.[105]

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[104] J. Myron Atkin, "Elementary School Science Programs: Appraisal and Recommendations," Improving Science Programs in Illinois Schools ed. William O. Stanley, Harry S. Broudy, and R. Will Burnett (Urbana; University of Illinois, 1958), p. 42.

[105] Donald Stotler, "The Supervision of the Science Program," Rethinking Science Education, Fifty-Ninth Yearbook of the National Society for the Study of Education, Part I (Chicago: University of Chicago Press, 1960), pp. 226-227.

The supervisor's responsibility in developing an adequate in-service program seems to be constantly emphasized. In science education, the need for in-service training of teachers has been intensified by the rapid changes made in both content and methods of teaching. Eiss related this problem to science curriculum materials developed by projects sponsored by the National Science Foundation when he stated:

> The majority of science teachers being graduated from our colleges in June will be prepared to teach science of the 1940's. Most of them will be relatively uninformed of the results of scientific research of the last decade, and with the courses of study now being used in hundreds of our nation's schools . . . . administrators cannot find enough teachers qualified to teach BSCS biology, CBA or CHEMS chemistry, or PSSC physics.[106]

Woodburn in speaking to state science supervisors also related the new science curriculum materials to the functions of the science supervisor.

> Things are building up on your side. Textbooks are becoming available that must be literally millions of dollars better than those they are to replace. . . . I know of no better way of improving science teaching than for supervisors to help science teachers to teach in the true spirit of science consistent with its methods, and complementary to its functions.[107]

Most of the literature dealing with the role of the science supervisor indicates supervisory activities similar to those recommended for the general supervisor except those activities that are unique to science education and vertical articulation. Atkin states that the procedures used by a science consultant as he attempts to improve the quality of science instruction would include:

> . . . demonstration teaching, developing printed curriculum aids, conducting workshops in elementary science for teachers, holding

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[106] Albert F. Eiss, "Report of the Committee for Relations with Supervisors of Science," (Thirty-Seventh Annual Meeting of the National Association for Research in Science Teaching, Chicago, March 21-24, 1964), p. 1. (Mimeographed.)

[107] John H. Woodburn, "The First-Problem: Helping the Teacher," School Life, Vol. 45 (October, 1962), 32.

> individual planning conferences with teachers to make suggestions for improvement of the science program, ordering and storing science equipment and books, and working with administrators in helping them to see the importance of science in the total curriculum.[108]

Tannenbaum[109] stresses that the science supervisor serves four functions: develops an in-service program in science; prepares or supervises the preparation of the science curriculum; helps teachers see their weaknesses and capitalize on their strengths; and coordinates the science program of the entire school system.

Battle[110] agrees with these, but also emphasizes that the science supervisor should assist in the identification and acquisition of instructional aids; should share in the evaluation of programs and in the revision of goals and procedures. MacLean, in addition to those activities already stated, stresses that the science supervisor should "act as liaison between community, industry and the science teacher. . . ."[111]

As one result of a conference June 25-29, 1962, sponsored by the U.S. Office of Education, guidelines for the activities of state science supervisors were developed in the areas of "professional and public relations, preservice and inservice education, curriculum facilities and equipment, research, and the nature of science."[112]

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[108] J. Myron Atkin, "Needed: Elementary School Science Counsultants," The Science Teacher, XXIV (October, 1957), 271.

[109] Harold E. Tannenbaum, "Supervision of Elementary School Science: In-Service Courses," The Science Teacher, XXVII (April, 1960), 50-51.

[110] Haron J. Battle, "Supervision in Science and Mathematics," School Science and Mathematics, LXI (April, 1961), 303.

[111] Archie J. MacLean, "Supervision of Guidance Toward Science," Education, LXXIII (March, 1953), 437.

[112] Uhlman S. Alexander, Supervision for Quality Education in Science (Washington, D. C.: U.S. Department of Health, Education, and Welfare, Office of Education, 1963), p. 163.

In a recent pamphlet developed for the National Science Teachers Association, George stressed that the typical duties of the science consultant were to

> . . . be of specific help to teachers in the classroom . . .; carry out a continuing inservice program . . .; to develop specific items of assistance for the science teacher such as newsletters, and lists of equipment and materials . . .; help teachers work with, and plan for, special groups of students . . .; help guidance bureau by alerting teachers and guidance counselors to science career materials . . .; assist administrators plan for and carry out the science program . . .; coordinate the work of the elementary and senior high schools . . .; help in evaluation of textbooks, library books and other printed materials . . .; advise or accompany teachers on field trips by helping with pre-trip and post-trip activities . . .; help in such activities as science fairs, congresses, and clubs . . .; and develop or review a curriculum guide for the teaching of science by serving as chairman of the curriculum committee.[113]

Related Studies

Studies have been conducted concerning the duties and responsibilities of the science supervisor, but no studies have been conducted to determine his responsibilities as related to the selection and implementation of different science curriculum materials. The studies in this and previous sections dealing with the role of the general and special supervisor were used as the basis for writing questions for Part II of the questionnaire. The review of related research, therefore, reveals that previous studies are different than the present study and resulted in a summary of those duties and responsibilities of the science supervisor which would have a high probability of being pertinent to the present study.

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[113] Kenneth D. George, "How to Utilize the Services of a Science Consultant...to Improve School Science Programs," How To Do It Pamphlet Series (Washington, D. C.: National Science Teachers Association, 1965), 2.

Culver conducted a statistically treated survey of learning problems in science education of nearly 900 pupils in a selected high school, accepted the objectives of science education as outlined by the Thirty-first and Forty-sixth Yearbooks of the National Society for the Study of Education and made a series of recommendations which represented "the pooled judgements of the majority of 32 jury members."[114] The supervisory program, outlined in this study for a specific high school, illustrates the importance of science curriculum materials, including textbooks, laboratory facilities, and audio-visual materials. The weakness of Culver's study was that it presented a supervisory program for a specific high school and the results, therefore, cannot be generalized.

Kerr[115] interviewed 50 professional school employees, made 25 observations, and collected statements from working consultants concerning effective supervisory practices to determine the role of the consultant in elementary school science. Among the most important functions of the science consultant found were: to plan, organize, and maintain a continuing in-service program for teachers and to assist with instructional materials and equipment. Kerr concluded that the functions of the elementary science consultant were:

> . . . to initiate, expand and enrich the science program; to work toward better personal relationships; to coordinate curriculum activities; to act as a resource person; to assist in

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[114] Ivon E. Culver, "A Supervisory Program for Improving the Learning of Science in a Senior High School" (unpublished Ed.D. dissertation, School of Education, University of Pennsylvania, 1952), p. 204.

[115] Elizabeth Feeney Kerr, "The Role of the Consultant in Elementary Science: A Report of a Type C Project" (unpublished Ed.D. dissertation, Teachers College, Columbia University, 1956), pp. 15-36.

in-service education programs; and to provide for continuous evaluation.[116]

In 1958 Lee reported the results of a questionnaire study to determine the status of supervision of secondary school science instruction at the state and local level and to evaluate the performance of supervisory activities in light of the established values procured through the judgements of a jury of 25 science educators. A check-list questionnaire was sent to 30 science educators, 44 local science supervisors, and 10 state science supervisors. Respondents ranked the 106 supervisory activities which were in eight major categories. The science educators who were declared the jury showed that the rank order of categories of activities used in the study were:

> (1) methods, (2) curriculum study, (3) research, (4) in-service growth of teachers, (5) self-growth, (6) public relations, (7) administration, and (8) materials and equipment.[117]

But the science supervisors did not entirely agree with this rank order.

> The three highest ranked categories of activities in terms of extent of performance by the supervisors of science are (1) Methods, (2) Administration, and (3) Curriculum study. The remaining categories are ranked in the following order: (4) Materials and Equipment, (5) Public Relations, (6) Self-Growth, (7) In-Service Growth of Teachers, and (8) Research.[118]

He found the following rank correlations: between state science supervisors and the jury of +0.45; between the jury and the local science supervisors of +0.53; and between state and local science supervisors of +0.85. Rank correlations according to Siegel[119] indicate the degree

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[116] Ibid., p. 96-97.

[117] Verlin Wiley Lee, "The Evaluation of Supervision of Secondary-School Science Instruction" (unpublished Ph.D. dissertation, Ohio State University, 1958), p. 246.

[118] Ibid., p. 251.

[119] Sidney Siegel, Nonparametric Statistics for the Behavioral Sciences (New York: McGraw-Hill Book Company, 1956), pp. 202-239.

of agreement between the groups. The results of Lee's study, therefore, indicate that there was much greater agreement between local and state science supervisors than between state science supervisors and college science educators or between local science supervisors and college science educators. If these results are valid, it is then more logical to consider the local science supervisors in the same category or group than to consider college science educators and science supervisors in the same category or group. From the design of the study and the recommendations Lee made from it, apparently he assumed that science educators knew what the role of the science supervisor ought to be. For example, he stated:

> The greatest need is more consultative aid to carry on programs that will more nearly correlate with values expressed by leading science educators.[120]

In 1959 Heimler[121] reported a study which resulted in the development of a guide for supervision in science in small New York Central schools. He developed a check-list questionnaire and mailed it to 529 science teachers employed in 249 small New York Central schools. From analyses of the questionnaire data, he determined the status of science education, the problems encountered by the science teachers, and developed a list of 96 science teaching recommendations. He then searched the literature on instructional supervision and developed a list of 16 supervisory methods and techniques which were validated by a jury. This list included: observational visits; individual and group conferences

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[120] Verlin Wiley Lee, "The Evaluation of Supervision of Secondary-School Science Instruction," Dissertation Abstracts, XIX (1959), 2290.

[121] Charles Herbert Heimler, "A Guide for Science Supervision in the New York Central School" (unpublished Ed.D. dissertation, School of Education, New York University, 1959), pp. 87-90.

with teachers; workshops; in-service education including on-campus and off-campus college courses; furnishing teachers with instructional aids and materials; providing consultant services; encouraging teachers to participate in professional organizations; arranging for teachers to visit and observe other teachers; evaluation, planning, the use of community resources and resource people; summer institutes; and summer employment. Three additional methods and techniques were added by the jury: teachers demonstrate successful classroom procedures to other teachers; teachers share summer institute experience; and demonstration teaching by the supervisor. These supervisory activities together with the analysis of teacher problems were used to develop a Guide for Science Supervision in the New York Central School.

Ploutz, in 1960, reported a questionnaire survey conducted to determine the conditions of employment, status, and professional responsibilities of science supervisors. The responses of 25 science supervisors in each of the areas of elementary, secondary, K-12, and state science supervisors were used in the study. Of the 38 items in the questionnaire that dealt with the responsibilities of the science supervisor, the following ten are listed in descending order of the number of times reported by science supervisors at the four levels:

1. Class visitation and teacher conference.
2. Curriculum development.
3. Promote in-service training, workshops, etc.
4. Provide equipment and materials for instructional purposes.
5. Provide or produce newsletters, bulletins, materials and information.
6. Evaluation of schools, courses, or instruction.
7. Survey films, texts, teaching materials for libraries, schools and teachers.
8. Promote and attend local, state, regional and national organizations.
9. Keep informed of new methods and materials by attending meetings and devoting time each day to reading professional literature

and reports.

10. Be available to answer questions, assist classroom teachers.[122]

However, since the science supervisors responded yes, no and/or on request, the data does not reveal the frequency in which the activities were performed or their relative importance. Rather it means that the science supervisors, as a group, feel these activities are performed by the science supervisor.

Turner conducted a questionnaire study to determine the practices employed by 25 science consultants working in the elementary schools in New York City and the relative efficiency of these practices as judged by school personnel. He found that the "three science consultant practices rated most valuable were: (1) held a grade workshop in science, (2) gave a science in-service course, and (3) gave a demonstration lesson."[123] He found a relatively high rank correlation between the following categories of respondents: between science consultants and principals; between consultants and superintendents; and between principals and superintendents. But he found a relative low correlation between practices which were actually employed and those rated valuable. This is further evidence that any study concerning the science supervisor's role should include actual and recommended behaviors of the supervisor.[124]

In 1961 Harwell reported a questionnaire inquiry concerning the responsibilities of the science supervisor as indicated by science

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[122]Paul F. Ploutz, "The Science Supervisor" (unpublished Ed.D. dissertation, Colorado State College, 1960), p. 108.

[123]Richard Timothy Turner, "An Appraisal of the Practices of Twenty-Five Science Consultants Operating in the New York City Elementary Schools" (unpublished Ph.D. dissertation, Fordham University, 1960), pp. 85-86.

[124]*Ibid.*, p. 55.

teachers employed in school systems with a science supervisor and who were members of the National Science Teachers Association. Each participant was asked the frequency with which the science supervisor performed the listed responsibility, which item in each section was thought to be most important, and whether each item should be the responsibility of the science supervisor.

The items from each section of the questionnaire which were considered most important by the greatest number of respondents indicated that the science supervisor:

1. Visits the new teacher in the system more often than others.
2. Holds group meetings of science teachers at intervals during the school year to encourage the exchange of ideas.
3. Encourages teachers to strive constantly to develop scientific attitudes and an appreciation for the method of science.
4. Assumes the leadership role in preparation of recommended courses of study for science.
5. Prepares lists of recommended equipment and supplies to be used in science classes.
6. Encourages the teacher to experiment and discuss findings to create a desire in students to do research.
7. Serves as a coordinator in developing an instructional philosophy of science.
8. Attends institutes and workshops held at colleges and universities.
9. Participates in policy making in regard to the science programs of the school system.
10. Is available for personal counseling of science teachers.
11. Assists in making plans for science facilities in new buildings.
12. Publicizes events concerning the science program.[125]

Wrobleski[126] conducted a questionnaire study concerning the duties and responsibilities of science coordinators in large public school

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[125] John Earl Harwell, "The Responsibilities of the Science Supervisor as Indicated by Science Teachers" (unpublished Ed.D. dissertation, University of Mississippi, 1961), pp. 176-177.

[126] Bernard E. Wrobleski, "The Duties and Functions of a Science Coordinator in a 9-12 Science Program in Selected School Districts in the United States" (unpublished Master's thesis, Indiana State College, Indiana, Pennsylvania, 1965), p. 40.

districts in the United States as to their current and recommended supervisory practices. He found that science coordinators recommended more involvement than is in current practice in the following areas: (1) science curriculum development, (2) science materials of instruction, (3) in-service training of science teachers, (4) personnel responsibilities, and (5) activities and services related to instruction.

The National Science Supervisors Association's (NSSA) Commission on the Role of Science Supervisors distributed a questionnaire to those NSSA members who attended the 1965 NSSA Annual Convention to obtain information concerning the role of the science supervisor. A study of the completed questionnaires indicate that the most significant duties of the science supervisor are related to: improving classroom instruction, curriculum development and implementation, counseling teachers and helping them, in-service teacher training, providing leadership, and providing instructional materials.

Jackson[127] studied the part-time supervisor of science-mathematics in Oklahoma public schools and a portion of his findings were the supervisory functions these supervisors think they should perform. Eighty percent or more of the part-time supervisors thought they should help determine the courses in science-mathematics; help formulate rules and regulations concerning how courses are taught; help formulate policy dealing with course enrollment requirements; consult with teachers when they have instructional problems; provide leadership in the formulation of course objectives; provide leadership in the selection of textbooks,

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[127]Tillman V. Jackson, "The Scope and Nature of Quasi-Supervision in the State of Oklahoma with Focus upon the Status and Role of Quasi-Supervisors of Secondary Science and Mathematics" (unpublished Ed.D. dissertation, University of Oklahoma, 1965), p. 126.

audio-visual aids, and other teaching materials; subscribe to at least two professional journals; keep well informed of the latest surveys, experiments, and other activities in their field; initiate or recommend program changes or changes in practices based upon current research findings; and keep teachers informed of the latest findings and programs.

To the knowledge of the writer, these are the only studies that relate directly to the role of the science supervisor. None of these studies considered the type of instructional materials being implemented as influencing the activities or responsibilities of the science supervisor. Most of the studies, however, offer evidence of the importance of curriculum development or the selection and implementation of science curriculum materials as being an integral part of the science supervisor's role.

After considering all the factors discussed in this chapter, it appears that the present study builds logically upon the findings of previous studies and extends the present knowledge concerning the role of the science supervisor by determining whether science supervisors use the same activities to the same extent in implementing NSF sponsored science project materials as those science supervisors implementing commercial materials.

Summary

The current literature on the role of the general supervisor indicates that his responsibilities are in the areas of curriculum development, leadership, in-service programs, self-growth, public relations, selection and use of curriculum materials, evaluation, and research. Further, the literature concerning the special supervisor indicates that he assumes a role similar to that of the general supervisor, but with greater emphasis on the articulation among the several grade levels, the selection and implementation of the specific instructional materials in the discipline, and the methods of teaching that particular discipline.

The studies concerning the science supervisor tend to reinforce these conclusions because the role, as revealed by the studies reviewed, places greater emphasis on the selecting and use of instructional materials including equipment-supplies, and on the use of laboratory facilities than did the studies on the role of the general supervisor.

From the literature, therefore, it seems logical that the areas of curriculum, leadership, in-service programs, and equipment-materials would be among the most pertinent areas in studying the science supervisor's role in relation to the type of curriculum materials being implemented.

CHAPTER III

PROCEDURE AND DESIGN

This chapter includes: (1) the design of the study, (2) the selection of the population, (3) the development of the questionnaire, (4) the establishment of procedures for the collection of data, and (5) the procedures for the analyses of data.

Design of the Study

The study was designed to determine and analyze the role of the science supervisor in the selection and use of both commercial and National Science Foundation (NSF) sponsored science curriculum project materials. Responses from a large number of persons were desired in determining the role of the science supervisor, and the questionnaire technique was especially appropriate for the purpose. A mailed questionnaire was used, therefore, to collect data from a national population of science supervisors, college science educators, and elementary and secondary school teachers.

The hypotheses of the study were developed from a careful review of science curriculum materials intended for grades K-12 and the professional literature concerning supervision. A comparison of the NSF sponsored science project materials with various commercial science curriculum materials raised several questions which eventually were transformed into hypotheses 1 and 2. A review of the professional literature and studies to find recommended science supervisory practices for implementing these widely different programs raised several other questions which were eventually transformed into hypotheses 3, 4, and 5.

The following null hypotheses, then, set the major structure for this study:

Null Hypotheses

Ho_1 Science supervisors and teachers using National Science Foundation (NSF) sponsored science project materials do not differ from those using commercial science curriculum materials as to the perceived relative importance of particular characteristics of science curriculum materials (Ho_1: $CM_1 = CM_2$).

Ho_2 Science supervisors and teachers using NSF sponsored science project materials do not differ from those using commercial science curriculum materials as to the perceived relative importance of selected objectives of science education (Ho_2: $Obj_1 = Obj_2$).

Ho_3 Science supervisors and teachers using NSF sponsored science project materials do not differ from those using commercial science curriculum materials as to the perceived actual behavior of science supervisors (Ho_3: $AB_1 = AB_2$).

Ho_4 Science supervisors and teachers using NSF sponsored science project materials do not differ from those using commercial science curriculum materials as to the recommended behavior of science supervisors (Ho_4: $RB_1 = RB_2$).

Ho_5 The perceived actual behaviors of science supervisors of grades K-6 do not differ from the perceived actual behaviors of science supervisors of grades 7-12 (Ho_5: $AB_{ele} = AB_{sec}$).

The null hypotheses were rejected and corresponding alternate hypotheses were accepted if statistical test values fell within the region of rejection set at the 0.05 level of significance. The alternate hypotheses were stated in Chapter I and in each case indicate differences between the two professional groups compared. Symbolically the alternate hypotheses may be stated as:

$$H_1: \ CM_1 \neq CM_2$$

$$H_2: \ Obj_1 \neq Obj_2$$

$$H_3: \ AB_1 \neq AB_2$$

$$H_4: \ RB_1 \neq RB_2$$

$$H_5: \ AB_{ele} \neq AB_{sec}$$

Many research designs were possible to collect sufficient data to test the null hypotheses and also limit the mailed questionnaires to a manageable number. For example, all of the NSF sponsored science project materials could have been studied within one state, or materials from several projects could have been studied nationally. Since the objectives of the NSF sponsored science projects are similar, the better design was to select materials from a few elementary and secondary sponsored projects and select respondents from a national population of science supervisors, elementary and secondary school teachers, and college science educators. This design enabled a greater generalization of results than many of the other possible designs.

Since elementary teachers usually teach other subjects as well as science, they are less likely to be familiar with NSF sponsored science projects than are secondary school science teachers, who usually specialize in one subject area. Science curriculum materials were, therefore, selected from three elementary NSF sponsored science projects and one secondary NSF sponsored project.

A questionnaire structured to obtain responses on a five-point scale was designed, pretested, revised, and mailed to a national sample of science supervisors and science teachers who were involved in the implementation of NSF sponsored and commercial science curriculum materials. Questions in Part I of the questionnaire were concerned with the relative importance of characteristics of science curriculum materials and in Part II with the relative frequencies of those supervisory activities directly related to the implementation of science curriculum materials: namely,activities related to curriculum, leadership, in-service programs, and equipment-materials.

Relationships in the data were determined by Spearman rank correlation coefficients and hypotheses were tested by the chi square test. A flow chart of the study design is shown in Diagram I.

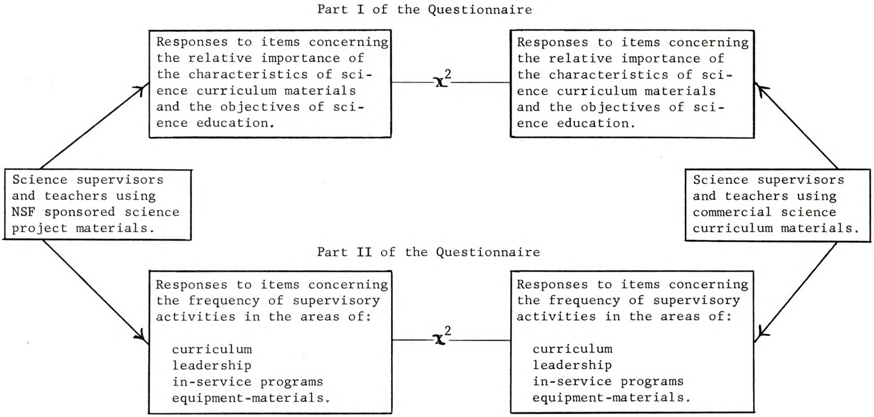
Selection of the Population

To fulfill the purpose of this study, it was necessary to classify each respondent as using NSF sponsored science project materials or as using commercial science curriculum materials. Since science teachers and science supervisors are directly involved in activities related to the utilization of science curriculum materials, they could readily be classified. In addition, previous studies and role theory indicate that teachers influence the science supervisors' role greatly. For these reasons, teachers, as well as science supervisors, were designated as role definers in this study.

The population, therefore, consisted of: (1) the total membership of the National Science Supervisors Association (NSSA), those

DIAGRAM I

QUESTIONNAIRE ITEMS RELATED TO THE RESEARCH DESIGN



χ^2 is the symbol for the chi square test.

persons identified as science supervisors in Wrobleski's study,[1] and the project coordinators of elementary school science materials developed by the American Association for the Advancement of Science (AAAS) Commission on Science Education and by the University of Illinois, Urbana; and (2) a random sample of science teachers working with a science supervisor who participated in this study by returning the completed questionnaire.

College science educators were also included in the study because they are involved in the preparation of teachers and science supervisors and have insight regarding recommended supervisory behaviors. Since a portion of the study concerned recommended behaviors of science supervisors, the inclusion of college science educators enabled comparisons between the responses of: college science educators and science supervisors; college science educators and teachers. Therefore, the total membership of the Association for the Education of Teachers of Science (AETS) was used to reinforce this portion of the study.

Development of the Questionnaire

A questionnaire was designed to collect information to test the hypotheses and to meet the objectives of the study based on the following points:

1. personal information about the respondents such as academic training, highest degree held, professional experience, and work load (See Appendix B)

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[1]Bernard E. Wrobleski, "The Duties and Functions of a Science Coordinator in a 9-12 Science Program in Selected School Districts in the United States," (unpublished Master's dissertation, Indiana State College, Indiana, Penna., 1965), pp. 1-96.

2. information concerning the types of curriculum materials being used by science supervisors and teachers essential for classifying the respondents
3. characteristics of science curriculum materials
4. selected objectives of science education
5. science supervisory activities in implementing science curriculum materials in the areas of curriculum, leadership, in-service programs, and equipment-materials.

Part I of the questionnaire was developed to obtain adequate information to test null hypotheses 1 and 2. In order to determine the items in this section, the objectives of science education were derived by the investigator from educational objectives as developed by the NEA Project on Instruction and the nature of science. The development of these objectives was discussed in Chapter II. These objectives were the basis of statements and counter statements describing science curriculum materials. Part II of the questionnaire was designed to obtain adequate information to test null hypotheses 3, 4, and 5. This part of the questionnaire consisted of statements describing behaviors of the science supervisor in implementing science curriculum materials. To determine these items, the professional literature was studied as reported in Chapter II and those items selected are related directly to the purposes of this study.

The questionnaire was designed so that two responses were made to each statement: one indicated the actual behaviors of the science supervisor as perceived by the respondent; the second indicated the recommended behaviors of the science supervisor. Both responses were made on a five-point scale.

Nine drafts of the questionnaire were prepared before it was printed and mailed. The first five drafts were prepared in June and July, 1965 and were presented to panels of doctoral candidates in education at Michigan State University. The size of these panels varied from two to five doctoral candidates. In addition to the comments from these panels, the ideas from Nixon,[2] Lowery,[3] and Backstrom and Hursh[4] were helpful in constructing the questionnaire. Payne's[5] suggestions were helpful in stating and restating the questions to communicate the desired meaning.

The comments from panel members and the study of these references resulted in restating many of the questionnaire items for clarity and in changing the physical arrangement of the questionnaire. Draft six was duplicated and reviewed by five of the faculty in the college of education and eight doctoral candidates at Michigan State University.

Further refinement of the questionnaire was accomplished by using the seventh draft in the pilot study designed to pretest the questionnaire. The pilot study was conducted September 15 to October 15, 1965 with the members of the National Science Supervisors Associations' Commission on the Role of the Science Supervisor and a sample of teachers under their supervision; the Science Curriculum Committee of the Michigan

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[2]John E. Nixon, "The Mechanics of Questionnaire Construction," Journal of Educational Research, XLVII, (March, 1954), 481-487.

[3]Robert A. Lowery, "The Questionnaire in Business Education Research," The National Business Education Quarterly, XXVII, (March, 1959), 5-10.

[4]Charles H. Backstrom and Gerald D. Hursh, Survey Research (Evanston:. Northwestern University Press, 1963), pp. XIX + 192.

[5]Stanley L. Payne, The Art of Asking Questions, (Princeton: Princeton University Press, 1951) pp. VII + 249.

State Department of Education; secondary science teachers trained at Michigan State University to conduct in-service programs for elementary teachers; and the members of the 1965-1966 NSF sponsored Academic Year Institute at Michigan State University. Of the 175 questionnaires distributed during the pilot study, 57 percent were returned. In addition, 18 pilot study respondents were interviewed individually; the time varied from 20 to 120 minutes each. The interviews were tape-recorded, and the recordings were systematically analyzed. Portions of the interviews were structured to determine whether different respondents interpreted the questionnaire items and scales in the same way. Other portions of the interview were not structured in an attempt to assess the over-all reaction of respondents to the study and to the questionnaire.

There were 40 usable returns and the data were analyzed through the use of the Control Data Corporation 3600 Computer to obtain information useful in revising the questionnaire. The pilot study questionnaire was revised, then, on the basis of the interviews, the difficulty encountered by the respondents in completing the questionnaire, and the results of the computer analyses. Few people had difficulty with the individual items of Parts I and II of the questionnaire, but many thought the questionnaire was too lengthy and required too much time to complete. The pilot study proved very useful in suggesting changes, especially in the personal information portion of the questionnaire. The investigator discussed the results of the pilot study with members of his doctoral committee before preparing the final questionnaire.

As a result of the pilot study and the discussions with members of the doctoral committee, Part I of the questionnaire was reduced from 22 to 18 items, Part II of the questionnaire was reduced from 75 to 64 items, and the personal information forms were revised greatly to furnish more accurate information to enable the investigator to more precisely classify respondents as using NSF sponsored science project materials or as using commercial science curriculum materials. The final questionnaire, including the personal information forms, is presented in Appendix B.

Collection of Data

In an effort to increase the percentage of questionnaires returned, a number of research techniques were used. These included the following:

1. A personally addressed letter to each science supervisor and college science educator was made possible by multilithing the body of the letter on Michigan State University letterhead and individually addressing the letters using the same typewriter that cut the multilith master. The resulting letters closely resembled personally typed letters. Since questionnaires to the teachers were mailed to and distributed by their science supervisors, form letters were used with the teachers.
2. All letters were personally signed by the investigator.
3. A multilithed letter in which the acting Superintendent of Public Instruction of the State of Michigan, Alexander J. Kloster, encouraged participants to respond to the questionnaire was also included to each respondent.
4. A stamped, self-addressed envelope was supplied to facilitate returns.

5. A date was designated in the cover letter for the return of forms.
6. Follow-up letters were mailed promptly to all those who had not returned the forms by the designated date. In addition to this, a second follow-up consisting of a double postcard was mailed to the science supervisors two weeks after the follow-up letter.
7. A summary of the findings was promised to all those who returned the completed forms.
8. A number two pencil was included to encourage each respondent to complete the IBM mark sensing response sheet.

Samples of materials mailed to respondents are included in the Appendices: the cover letters are presented in Appendix A, the questionnaire in Appendix B, and the follow-up letters in Appendix C.

Copies of the final questionnaire were mailed to:

1. the total membership of the National Science Supervisors Association (NSSA), members of the Association for the Education of Teachers of Science (AETS), those persons identified as science supervisors in Wrobleski's study,[6] and project coordinators of elementary school science materials developed by the AAAS Commission on Science Education and by the University of Illinois, Urbana; and
2. a random sample of science teachers working with a science supervisor who participated in this study by returning the completed questionnaire.

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[6]Wrobleski, pp. 1-96.

Two separate mailings of the questionnaire were necessary: one to 464 science supervisors and 306 college science educators (AETS members) to identify those actively involved in science supervision and to obtain essential information about the teachers with whom they work; a second mailing of 508 questionnaires to the science supervisors who in turn distributed them to a random sample of their teachers. To detect changes in professional positions since the mailing lists were formed, participants who received the questionnaire on the first mailing classified themselves as science supervisors or non-science supervisors based on a given definition of science supervisor. Fifty-nine persons on the mailing lists of science supervisors classified themselves as college science educators and completed only the recommended behavior portion of the questionnaire. Their responses were analyzed with the responses from other college science educators.

Of the questionnaires mailed, requested forms were returned by 68.4 percent of the science supervisors, 69.0 percent of the teachers, and 62.2 percent of the college science educators as is shown in Table 1.

Five science supervisors, eleven college science educators, and 43 teachers were not included in the analyses because they did not complete the portion of the questionnaire necessary for classification or they did not complete the main body of the questionnaire. Responses used in the analyses came from 246 science supervisors, 311 teachers, and 218 college science educators. These totals include 31 respondents from the pilot study: 11 science supervisors, and 20 teachers.

Each science supervisor or teacher was classified as using NSF sponsored science project materials or commercial science curriculum materials based on the degree to which he was using one or more of:

1. The elementary school science curriculum materials developed by the AAAS Commission on Science Education; Educational Services, Inc.; or the Elementary School Science Project, University of Illinois, Urbana.
2. The Biological Sciences Curriculum Study (BSCS) materials; specifically the yellow, blue, or green versions.

TABLE 1

NUMBERS OF QUESTIONNAIRES MAILED AND RETURNED

	Science Supervisors	Teachers	College Science Educators
Total Questionnaires Mailed	464	508	306
Returned Unopened	27	24	33
N Used to Calculate Percentages	437	484	273
Completed Forms Returned	299	334	170
Percentage of Completed Forms Returned	68.4	69.0	62.2
Number of Returns Not Usable	5	43	11

As a portion of the personal information form, each science supervisor indicated the percentage of elementary classes and of secondary biology classes using the above science curriculum materials under his supervision. Similarly each teacher indicated the percentage of his students using the above materials. In order to determine the minimum percentages which would be used to classify respondents as using NSF sponsored science project materials, the investigator talked with those associated with the above projects and searched the literature in an attempt to determine how extensively these materials were being used in the United States. As a result, it was estimated that one percent of the elementary school children and 40 percent of the secondary school biology students were using the above materials. Respondents using the above materials equal to or greater than these percentages were classified as using NSF sponsored science curriculum materials; others were classified as using commercial science curriculum materials. The results of this classification are presented in Table 2.

TABLE 2

NUMBER OF RESPONDENTS CLASSIFIED AS USING NSF SPONSORED SCIENCE PROJECT MATERIALS AND USING COMMERCIAL SCIENCE CURRICULUM MATERIALS

	Science Supervisors		Teachers	
	NSF	Commercial	NSF	Commercial
Elementary	24	22	64	75
Secondary	53	52	96	76
Grades, K-12	56	39		
	133	113	160	151

Procedures for Analyses

Research data are usually classified into one of four types--nominal, ordinal, interval, and ratio.[7] The type of data, the population variables, and the research design dictate the general group of analytical tools applicable to the data. The questionnaire for this

[7]William L. Hays, Statistics for Psychologists (New York: Holt, Rinehart and Winston, 1963), pp. 68-73.

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study measured the participants response at the ordinal level of scaling. That is, the 0, 1, 2, 3, 4 rating was in order of increasing importance or increasing frequency, but not necessarily of equal intervals.

Since respondents were classified as using either the NSF or commercial science curriculum materials, these two groups were totally independent. The data from this study completely meets the requirements, therefore, of the chi square test.

> When the data of research consist of frequencies of discrete categories, the χ^2 test may be used to determine the significance of differences between two independent groups. The measurement involved may be as weak as nominal scaling.[8]

In keeping with the purposes of this study, the previously stated rationale for the analyses, and the limitation of the type of data as obtained from the questionnaire, the chi square test was selected as the statistical procedure to analyze the data in order to test the five hypotheses.

By the use of electronic data processing methods, the responses from all science supervisors and teachers were tabulated for each item on the questionnaire and frequencies obtained for each point on the five-point scale. Since respondents were classified as using NSF sponsored science project materials or commercial science curriculum materials, the ACT Computer Program[9] at Michigan State University which is designed as an analysis of contingency tables was used on the Control Data Corporation 3600 Computer to tabulate these frequencies, to construct two

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[8]Sidney Siegel, Nonparametric Statistics for the Behavioral Sciences (New York: McGraw-Hill Book Company, Inc., 1956), p. 104.

[9]F. M. Sims, L. C. Widmayer, and S. M. Lesgold, "Analysis of Contingency Tables (ACT) for the CDC 3600" (Computer Institute for the Social Science Research, Michigan State University, 1965) pp. 1-19. (Mimeographed.)

by five contingency tables, and to calculate the chi square values. The computer output also included the frequency and percentage for each cell and totals for all columns and rows. The appropriate null hypothesis was rejected or not rejected for each questionnaire item based upon the degrees of freedom and the magnitude of the chi square value. The 0.05 level of significance was used for the region of rejection.[10]

The chi square test had an additional advantage in this study because an examination of frequencies within the contingency tables for those items found to be significant enabled the investigator to determine whether those using NSF sponsored science project materials rated the item higher than those using commercial science curriculum materials or conversely.

In Part II of the questionnaire, 18 items dealt with curriculum; 17 items concerned leadership; 15 items pertained to in-service programs; and 14 items related to equipment-materials. To determine the relative reliability in each of these four groups of questions, intraclass correlation[11,12] was calculated for each group. The computer program-INCLRA[13] was used to perform these calculations. Relationships between those using commercial curriculum materials in each of these four areas, were determined by Spearman rank correlation coefficients and by the

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[10]Herbert Arkin and Raymond R. Colton, Tables for Statisticians (New York: Barnes & Noble, Inc., 1950), p. 121.

[11]Robert L. Ebel, "Estimation of the Reliability of Ratings," Psychrometrika, XVI (December, 1951), 407-424.

[12]J. P. Guilford, Psychrometric Methods (New York: McGraw-Hill Book Company, Inc., 1954), pp. 395-398.

[13]B. Lashbrook, "Program INCLRA: Reliability by the Intraclass Correlation", (Educational Development Program, Michigan State University, 1966) pp. 1-4. (Mimeographed.)

number of items that were significant through the chi square test. In analyzing the responses to Part II of the questionnaire, the population was stratified into three segments: (1) elementary school science supervisors and teachers; (2) secondary school science supervisors and teachers; and (3) science supervisors of both elementary and secondary school teachers. Separate analyses were made of segments 1 and 3 and of 2 and 3 to prevent differences between elementary and secondary school personnel from contributing to the magnitude of the chi square values or affecting correlation coefficients.

To calculate the rank correlation coefficients, the mean response for each item was calculated and the items within each category of curriculum, leadership, in-service programs, and equipment-materials were ranked according to these means. Spearman rank correlation coefficients were calculated by computer[14] using these rank orders of items for those using NSF sponsored science project materials and those using commercial curriculum materials.

Summary

A two part questionnaire was designed, pretested, revised, and distributed to a national sample of science supervisors and teachers to determine the role of the science supervisor in the selection and use of science curriculum materials. Part I of the questionnaire was designed to obtain adequate information to test null hypotheses 1 and 2 which dealt with the selection of curriculum materials. Part II of the questionnaire was designed to obtain adequate information to test null

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[14] John Morris, "Rank Correlation Coefficients", (Computer Institute for Social Science Research, Michigan State University, 1966), pp. 1-7. (Mimeographed.)

hypotheses 3, 4, and 5 concerning the science supervisor's actual and recommended behavior in implementation of science curriculum materials.

The data were analyzed through the use of the CDC 3600 Computer using chi square test, intraclass correlation, and Spearman rank correlation coefficients.

CHAPTER IV

ANALYSIS OF DATA AND FINDINGS

The data collected by the procedures described in Chapter III are presented in this chapter together with the results of analyses. The chapter is divided into five sections: (1) personal characteristics of science supervisors and teachers; (2) hypotheses and findings; (3) intraclass and rank correlations; (4) recommended behaviors of science supervisors as viewed by college science educators, science supervisors, and teachers; and (5) summary.

Personal Characteristics

A portion of the questionnaire provided information concerning the respondent's age; professional experience; highest degree held; and academic training in science, mathematics, and methods of teaching science. For these questions, no differences were found among any of the variables at the 0.05 level of significance using the chi square test between science supervisors or teachers using NSF sponsored science project materials and those using commercial science curriculum materials. Differences in the responses of these two groups to items in this study's questionnaire, therefore, cannot be attributed to differences in the personal characteristics tested. The personal information gathered is also helpful in describing the science supervisors and teachers used in this study.

Science Supervisors

Of the 246 science supervisor reports used, 79.5 percent indicated employment by a school district or system, 5.7 percent by a state department, and 10.2 percent by a county department. Of the science supervisors, 71.1 percent of them devote fifty or more percent and only 6.1 percent spend less than ten percent of their regular working hours in science supervision. The science supervisors' group was comprised of 38.6 percent from grades K-12, 18.7 percent from elementary schools and 42.7 percent from secondary schools.

The number of teachers under the supervision of a science supervisor varies greatly (Table 3). Nearly one-third have less than 50 teachers, and one-ninth have more than 700 teachers under their supervision. Some science supervisors have assistants who also have supervisory responsibilities. In fact, 4.8 percent of the science supervisors indicated more than three assistants; 4.5 percent indicated three assistants; 3.7 percent two, 8.1 percent one and 76.8 percent none.

TABLE 3

RELATIONSHIP OF SCIENCE SUPERVISORS AND THE NUMBERS OF SUPERVISED TEACHERS

Percentage of Science Supervisors	Number of Teachers
30.5	less than 50
10.2	51 - 100
9.4	101 - 150
13.0	151 - 250
10.6	251 - 350
5.7	351 - 450
5.7	451 - 550
1.6	551 - 700
11.4	more than 700

Science supervisors were asked if they were willing to distribute additional questionnaires to several elementary teachers and/or to several secondary biology teachers. Most science supervisors, 73.1 percent answered yes, 16.7 percent answered no, and 10.2 percent left the question blank.

Each science supervisor listed the percentage of elementary classes and/or biology classes using selected science curriculum materials in his school system or systems. A summary of these findings are presented in Table 4. Science supervisors reported using NSF sponsored science project materials less at the elementary than at the secondary school level. For example, the percentage using these materials in forty-one or more percent of their classes in elementary school science was 5.6 and in secondary school biology, 27.8.

One of the underlying assumptions of the questionnaire was that the science supervisor's responsibility include the areas of curriculum, leadership, in-service programs and equipment-materials as related to science education. Evidence supports this assumption. The percentages of science supervisors indicating major responsibility for leadership in the following areas were: 86.6 in selecting science curriculum materials, 88.2 in implementing science curriculum materials, 78.0 in organizing and maintaining an adequate in-service program, and 86.6 in selecting and supervising the use of equipment and supplies.

The full-time classroom experience of science supervisors amounted to 84.2 percent at the secondary school level and only 6.9 percent at the elementary school level. These facts are more meaningful when compared to the classification of the science supervisors: 18.7 percent were elementary school science supervisors, 42.7 percent were secondary

TABLE 4

PERCENTAGE OF CLASSES USING THE LISTED SCIENCE CURRICULUM MATERIAL AS INDICATED BY SCIENCE SUPERVISORS
N = 246

Science Curriculum Materials	Percentage of Classes					Total
	1 - 20	21 - 40	41 - 60	61 - 80	more than 80	
NSF Sponsored						
Elementary Science Study by Educational Services, Inc. (Houghton Mifflin Co.)	8.5	2.4	1.6	0.8	0.8	14.1
Elementary School Science Curriculum Materials by the AAAS Commission on Science Education	11.4	0.4	0.8	--	0.4	13.0
Elementary School Science Project Materials, University of Illinois, Co-directors: Atkin and Wyatt	8.5	--	--	--	1.2	9.7
Commercial						
Allyn and Bacon Science Series by Thurber	7.3	2.4	1.2	--	3.2	14.1
American Book Co. Science Series by Jacobson, Lauby and Konicek	8.1	3.3	0.4	0.4	2.4	14.6
D. C. Heath and Co. by Herman and Nina Schneider	6.9	3.7	5.3	3.2	12.2	31.3
Harper & Row, Publishers Science Series by Navarra and Zafforoni	5.7	5.3	3.2	2.0	4.1	20.3

TABLE 4--Continued

Science Curriculum Materials	Percentage of Classes					Total
	1 - 20	21 - 40	41 - 60	61 - 80	more than 80	
Macmillan Science Series by Barnard, Stendler, Spock and others	6.5	--	0.8	1.2	3.2	11.7
All others specified	4.5	5.7	2.8	2.4	11.0	26.4
NSF Sponsored						
BSCS Green Version: High School Biology, Rand McNally Company	19.5	7.3	1.2	2.8	4.9	35.7
Biological Science: An Inquiry Into Life (BSCS -- Yellow Version), Harcourt, Brace, and World Company	18.7	11.0	3.6	3.2	6.5	43.0
Biological Science: Molecules to Man (BSCS -- Blue Version), Houghton Mifflin Company	18.3	6.1	2.4	1.2	2.0	30.0
Commercial						
Exploring Biology: The Science of Living Things by Ella Thea Smith	10.6	2.0	2.8	0.4	0.8	16.6
Modern Biology by Moon, Otto, and Towle	5.7	11.4	7.3	9.8	12.2	46.4
All others specified	20.7	5.7	3.3	3.2	2.4	35.3

science supervisors and 38.6 percent were science supervisors of grades K-12. Overall, then, 57.3 percent of the science supervisors had responsibilities in the elementary school, but only 6.9 percent had their major teaching experience at that level.

Most science supervisors have at least a master's degree. A bachelor's degree alone was held by just 4.9 percent of the science supervisors, the master's degree by 79.3 percent, 13.4 percent attained the doctorate, and 2.4 percent left the question blank.

Of the science supervisors studied, 83.7 percent were men and 56.9 percent were 41 or more years of age. The ages of science supervisors were distributed over a wide range: 4.5 percent were less than 30; 35.0 percent were between 31 and 40; 26.0 percent, between 41 and 50; and 30.9 percent were more than 50 years old.

Most of the science supervisors had taught more than ten years and had been supervisors at least four years. These data are displayed in Table 5.

TABLE 5

PROFESSIONAL EXPERIENCE OF SCIENCE SUPERVISORS
N = 246

Professional Experience	Percentage of Science Supervisors					
	Years					
	1	2	3	4-6	7-10	more than 10
As a science teacher	--	2.0	0.8	12.2	22.0	62.2
As a science supervisor	5.7	9.8	12.6	35.4	19.1	16.3
In your present position	8.1	11.0	12.2	34.6	18.7	14.6
Total professional experience	--	0.4	--	4.5	13.4	81.3

The academic training of science supervisors varies greatly as shown in Table 6. For example, 9.3 percent of the science supervisors in chemistry, 4.4 percent in physics, 17.8 percent in biological science, 0.8 percent in earth science, and 2.0 percent in mathematics held 51 or more semester hours of college credit in these respective fields.

TABLE 6

ACADEMIC TRAINING OF SCIENCE SUPERVISORS
N = 246

College Training in	Percentage of Science Supervisors								
	Semester Hours								
	0	3-6	7-12	13-18	19-24	25-50	51-75	76-100	more than 100
Chemistry	0.8	6.1	18.7	13.0	15.4	31.3	7.7	1.2	0.4
Physics	2.4	10.2	26.0	17.9	16.3	17.1	3.2	0.8	0.4
Biological Science	3.2	4.9	12.6	14.6	12.2	32.5	13.4	2.8	1.6
Earth Science (including Geography)	14.2	32.5	25.2	7.7	3.7	5.3	0.4	--	0.4
Mathematics	4.1	15.4	24.4	23.2	15.8	14.2	1.6	0.4	--
Methods of teaching science	4.9	27.2	34.6	16.3	10.6	4.9	--	--	--

The portion of the questionnaire used to collect this information is presented in Appendix B.

Teachers

The responses from 311 teachers were used in the analyses: 139 were elementary school teachers; 172 were secondary biology teachers. Using the chi square test, no significant differences were found at the 0.05 level between elementary or secondary school teachers using NSF sponsored science project materials and those using commercial materials concerning the teachers' age, sex, grade level in which they were teaching, the number of students attending the schools in which they taught, and the highest degree held. Since the study concerns the role of the science supervisor, more personal information about the science supervisor was given in this chapter than for the teacher, but information concerning science curriculum materials used and concerning academic training of teachers was presented.

The percentage of elementary school teachers who indicated they were using particular science curriculum materials with 50 or more percent of their students is presented in Table 7. The 33.8 percent listed as other programs included 13.2 percent who indicated they were using local curriculum guides or their own programs and 3.6 percent who specified multiple textbooks.

Table 8 contains the percentage of secondary school biology teachers who indicated they were using a specific biology program with 50 or more percent of their students. Half of the secondary school biology teachers reported using BSCS materials with 50 or more percent of their students.

The academic training of elementary school teachers and secondary school biology teachers is presented in Table 9.

The portion of the questionnaire used to collect this information is presented in Appendix B.

Hypotheses and Findings

The findings in this section include the results of chi square analyses for each of the questionnaire items used to test the study's

TABLE 7

PERCENTAGE OF ELEMENTARY TEACHERS USING THE LISTED SCIENCE CURRICULUM MATERIALS WITH 50 OR MORE PERCENT OF THEIR STUDENTS
N = 139

Science Curriculum Materials	Percentage of Teachers
Elementary Science Study by Educational Services, Inc., (Houghton Mifflin Company)	2.9
Elementary School Science Curriculum Materials by the AAAS Commission on Science Education	15.8
Elementary School Science Project Materials, University of Illinois, Co-directors: Atkin and Wyatt	1.4
Allyn and Bacon Science Series by Thurber	2.9
American Book Company Science Series by Jacobson, Lauby and Konicek	1.4
D. C. Heath and Co. by Herman and Nina Schneider . .	13.0
Harper and Row, Publishers Science Series by Navarra and Zafforoni	3.6
Macmillan Science Series by Barnard, Stendler, Spock and others	2.9
Other programs, specified	33.8

TABLE 8

PERCENTAGE OF SECONDARY BIOLOGY TEACHERS USING LISTED SCIENCE CURRICULUM MATERIALS WITH 50 OR MORE PERCENT OF THEIR STUDENTS
N = 172

Science Curriculum Materials	Percentage of Teachers
BSCS Green Version: High School Biology, Rand McNally Company	16.8
Biological Science: An Inquiry Into Life (BSCS--Yellow Version), Harcourt, Brace & World Co.	23.3
Biological Science: Molecules to Man (BSCS--Blue Version), Houghton Mifflin Company	9.9
Exploring Biology: The Science of Living Things by Ella Thea Smith	5.8
Modern Biology by Moon, Otto and Towle	28.5
Other Programs specified	11.0

TABLE 9

ACADEMIC TRAINING OF ELEMENTARY SCHOOL TEACHERS (N = 139) AND SECONDARY SCHOOL BIOLOGY TEACHERS (N = 172)

College Training in	Percentage of Elementary or Secondary School Teachers								
	Semester Hours								
	0	3-6	7-12	13-18	19-24	25-50	51-75	76-100	more than 100
Elementary School Teachers									
Chemistry	28.8	22.3	10.8	2.2	2.9	0.7	--	--	--
Physics	26.6	33.8	5.0	--	--	0.7	--	--	--
Biological Science	6.5	39.6	25.2	4.3	4.3	7.9	1.4	--	--
Earth Science (including geography)	6.5	33.8	28.1	7.2	2.9	2.2	0.7	--	--
Mathematics	7.2	49.6	27.3	5.0	1.4	1.4	0.7	--	--
Methods of teaching science	11.5	52.5	15.8	4.3	2.2	1.4	--	--	--
Biology Teachers									
Chemistry	2.3	17.4	25.6	16.3	14.0	16.9	--	0.6	--
Physics	13.4	30.8	33.1	10.5	2.3	--	0.6	--	--
Biological Science	--	0.6	1.7	4.1	8.7	50.0	25.0	6.4	2.9
Earth Science (including geography)	14.5	36.1	16.9	8.1	2.3	0.6	--	--	--
Mathematics	8.7	36.1	32.0	8.1	4.6	1.2	--	--	--
Methods of teaching science	8.7	51.7	18.6	8.7	4.6	2.3	--	--	--

five hypotheses, the results of the intraclass and Spearman rank correlations, and the comparison of the recommended science supervisory behaviors as perceived by college science educators, teachers, and science supervisors. Most of the findings are presented in tabular form and the discussions are to aid the reader in finding pertinent data quickly within the tables.

Selection of Science Curriculum Materials

Part I of the study investigated the relative importance of characteristics of science curriculum materials and of the objectives of science education in selecting science curriculum materials as perceived by science supervisors and teachers using NSF sponsored science project materials and by those using commercial science curriculum materials. Specifically, two null hypotheses were tested: Ho_1 Science supervisors and teachers using NSF sponsored science project materials do not differ from those using commercial science curriculum materials as to the perceived relative importance of particular characteristics of science curriculum materials (Ho_1: $CM_1 = CM_2$).
Ho_2 Science supervisors and teachers using NSF sponsored science project materials do not differ from those using commercial science curriculum materials as to the perceived relative importance of selected objectives of science education (Ho_2: $Obj_1 = Obj_2$).

The responses of 246 science supervisors and 311 teachers to Part I of the questionnaire were analyzed to test null hypotheses 1 and 2. Nine items were specifically designed to test each hypothesis. Applying the chi square test to each of these items, significant differences were found between professional groups using NSF sponsored science curriculum materials and those using commercial science curriculum materials in five of the nine items designed to test Ho_1 and six of the nine items designed to test Ho_2. The chi square values are summarized in Appendix D.

The findings clearly indicate that there were differences between professional groups using NSF sponsored science project materials and those using commercial science curriculum materials. These specific differences are illustrated in Tables 10 and 11. Null hypothesis 1 (Ho_1: $CM_1 = CM_2$) was rejected and the alternate hypothesis accepted for every item listed in Table 10. Null hypothesis 2 (Ho_2: $Obj_1 = Obj_2$) was rejected and the alternate hypothesis accepted for every item listed in Table 11.

TABLE 10

ITEMS DESCRIBING SCIENCE CURRICULUM MATERIALS WHICH WERE PERCEIVED DIFFERENTLY BY PROFESSIONAL GROUPS USING NSF SPONSORED SCIENCE PROJECT MATERIALS AND THOSE USING COMMERCIAL SCIENCE CURRICULUM MATERIALS
N = 557

Questionnaire Item	Level of Significance
In selecting science curriculum materials, how important do you consider:	
* 2. materials that place major emphasis on teaching demonstrations or group experiences	0.001
5. materials that place major emphasis on science content topics such as weather, machines, electricity, magnetism, etc.	.001
10. materials that place major emphasis on qualitative observations and explanations	.05
11. materials that place major emphasis on facts and science principles	.001
16. materials that emphasize explanations to develop concepts	.01

*Question numbers correspond to those on the questionnaire presented in Appendix B.

TABLE 11

ITEMS DERIVED FROM OBJECTIVES OF SCIENCE EDUCATION WHICH WERE PERCEIVED DIFFERENTLY BY PROFESSIONAL GROUPS USING NSF SPONSORED SCIENCE PROJECT MATERIALS AND THOSE USING COMMERCIAL SCIENCE CURRICULUM MATERIALS
N = 557

Questionnaire Item	Level of Significance
In selecting science curriculum materials, how important do you consider:	
* 1. materials that place major emphasis on the individual laboratory approach to teaching and learning	0.05
3. materials that use laboratory experiences as the primary source of information	.05
6. materials that place major emphasis on learning how to observe, to form hypotheses, to design experiments and to draw valid conclusions	.001
9. materials that emphasize using quantitative observations and mathematics to study relations	.001
15. materials that place major emphasis on the investigative approach to concept development. . . .	.01
18. tests that measure the child's ability to use the methods of scientific inquiry.	.001

*Question numbers correspond to those on the questionnaire presented in Appendix B.

Upon examination of each contingency table from which the chi square value was calculated, the professional group rating the item higher was determined. Items listed in Table 10 were rated more highly by professional groups using commercial science curriculum materials while those listed in Table 11 were rated higher by professional groups using NSF sponsored science project materials.

In constructing Part I of the questionnaire, nine items were derived from this study's objectives of science education and an equal number of counter statements were developed. Note, in Tables 10 and 11, that four of the statements and their counter statements were

significant: items 1, 2; 5, 6; 9, 10; and 15, 16; these findings further demonstrate the differences between the two professional groups.

Actual and Recommended Supervisory Behavior

The second part of the study pertained to the actual and recommended behavior of the science supervisor in implementing science curriculum materials as perceived by professional groups using NSF sponsored science project materials and those using commercial science curriculum materials. Part II of the questionnaire was designed to obtain adequate information to test null hypotheses 3, 4, and 5. Two responses were made to each statement: one indicated the actual behaviors of the science supervisor as perceived by the respondent; the second indicated the recommended behaviors of the science supervisor.

The null hypotheses were:

Ho_3 Science supervisors and teachers using NSF sponsored science project materials do not differ from those using commercial science curriculum materials as to the perceived actual behavior of science supervisors (Ho_3: $AB_1 = AB_2$)

Ho_4 Science supervisors and teachers using NSF sponsored science project materials do not differ from those using commercial science curriculum materials as to the perceived recommended behavior of science supervisors (Ho_4: $RB_1 = RB_2$).

Ho_5 The perceived actual behaviors of science supervisors of grades K-6 do not differ from the perceived actual behaviors of science supervisors of grades 7-12 (Ho_5: $AB_{ele} = AB_{sec}$).

Null hypotheses 3 (Ho_3: $AB_1 = AB_2$) and 4 (Ho_4: $RB_1 = RB_2$) were tested by the chi square test for each item of Part II of the questionnaire. This part of the questionnaire contained 18 items dealing with curriculum, 17 items concerning leadership, 15 items pertaining to in-service programs, and 14 items related to equipment-materials. In order to prevent differences between elementary and secondary school personnel from affecting the chi square values, two separate analyses were made: one using responses of elementary school science supervisors and teachers; the other using responses of secondary school science supervisors and teachers. Complete summaries of chi square values are given in Appendices E and F.

The findings presented in Table 12 indicate differences between professional groups using NSF sponsored science project materials and those using commercial science curricula as to the actual and recommended behaviors of the science supervisor in the areas of curriculum, leadership, in-service programs, and equipment-materials.

In Table 12, the level of significance indicates the questionnaire item rejected for each null hypothesis and for each segment of the population. In addition, Table 12 shows which professional group rated each item higher: those using NSF sponsored science project materials or those using commercial science curriculum materials.

Curriculum

In general, the two professional groups of secondary school personnel differ on more items concerning curriculum than do the two professional groups of elementary school personnel. The two professional groups differ at both the elementary and secondary level, however, as to whether the science supervisor supports or ought to support teachers who try new curriculum materials and whether he encourages teachers or ought to encourage teachers to use science demonstrations.

The two groups of secondary school personnel differ more frequently

TABLE 12

ITEMS DESCRIBING ACTUAL AND RECOMMENDED SUPERVISORY BEHAVIOR WHICH WERE PERCEIVED DIFFERENTLY BY PROFESSIONAL GROUPS USING NSF SPONSORED SCIENCE PROJECT MATERIALS AND THOSE USING COMMERCIAL SCIENCE CURRICULUM MATERIALS ELEMENTARY, N = 280; SECONDARY, N = 372

Questionnaire Item	Elementary		Secondary	
	H_3	H_4	H_3	H_4
Curriculum				
The science supervisor:				
*29. gives support to teachers who try new curriculum materials.	0.001	0.05	0.001	0.05
34. encourages teachers to use science demonstrations.	.001**	.001**	.05**	.001**
37. encourages teachers to use individual laboratory experiences with pupils.	.01	.01	.01	--
41. encourages advanced and/or individual study programs for pupils interested in further opportunities in science.	--	--	.05	.05
43. works as an active member of committees or groups in determining local objectives of science education.	--	--	.05	--
44. meets with teachers to develop criteria for selecting science curriculum materials.	--	--	--	.05
45. meets with teachers to evaluate current curriculum materials on the basis of developed criteria.	--	--	.05	--
50. conducts meetings to coordinate the science program through several grade levels.	--	--	.05	--

*Question numbers correspond to those on the questionnaire presented in Appendix B.

**Denotes items rated higher by science supervisors and teachers using commercial science curriculum materials than those using NSF sponsored science project materials. The converse is true for items not marked.

TABLE 12--Continued

Questionnaire Item	Elementary		Secondary	
	H_3	H_4	H_3	H_4
*67. conducts parent meetings to explain the local science program.	--	--	.01	.05
77. arranges for teachers to evaluate films, filmstrips and other instructional aids.	.05**	--	--	--
Leadership				
The science supervisor:				
22. recommends teachers for committee chairmen and other leadership roles.	--	--	.05	--
28. encourages teachers to experiment with new ideas and practices in teaching science.	.05	--	.001	--
47. identifies problems or weaknesses in the science program and discusses them with the teachers.	.05	--	--	--
48. proposes curriculum changes.	--	--	.05	--
57. arranges for released time to enable teachers to attend in-service programs.	.05	--	.001	--
58. arranges for extra pay for teachers who attend in-service meeting.	--	--	.01	--
59. arranges for extra pay or reduced load for teachers who work with science-incentive programs.	--	--	.01	--
73. reports to teachers after he attends a professional meeting.	.05	--	.05	--
75. is actively involved in educational research.	.05	--	.05	.05

*Question numbers correspond to those on the questionnaire presented in Appendix B.

**Denotes items rated higher by science supervisors and teachers using commercial science curriculum materials than those using NSF sponsored science project materials. The converse is true for items not marked.

TABLE 12--Continued

Questionnaire Item	Elementary		Secondary	
	H_3	H_4	H_3	H_4
In-Service				
The science supervisor:				
*51. arranges for in-service programs that are directly related to the curriculum used with the pupils.	--	--	.05	--
54. makes use of the school laboratories as instructional centers for in-service education.	--	--	.05	.05
56. makes arrangements with a college or university to give college credit for in-service courses.	--	--	.01	--
66. secures the teacher's evaluation of the in-service programs.	.001	--	--	--
Equipment - Materials				
The science supervisor:				
33. coordinates the use of equipment from central storage.	.05**	--	--	--
35. arranges for supplementary facilities such as a portable laboratory table or a demonstration table suitable for pupil and teacher demonstration.	.05**	--	--	--
36. arranges for equipment and supplies for science demonstrations.	--	.01**	--	--
38. arranges for adequate science facilities and furniture suitable for experimentation by pupils.	--	--	--	.01
39. arranges for equipment and supplies in necessary quantities for sufficient individual pupil laboratory experiences.	--	--	--	.05

*Question numbers correspond to those on the questionnaire presented in Appendix B.

**Denotes items rated higher by science supervisors and teachers using commercial science curriculum materials than those using NSF sponsored science project materials. The converse is true for items not marked.

TABLE 12--Continued

Questionnaire Item	Elementary		Secondary	
	H_3	H_4	H_3	H_4
*78. meets with teachers to plan for changes in equipment, supplies, and resources to correspond to changes in the curriculum.	--	--	--	.05
79. meets with teachers to establish standards of selection and procurement of science equipment and supplies.	--	--	--	.05
80. aids teachers in arranging storage of laboratory equipment and supplies.	.001**	--	--	--
81. aids teachers in systematizing the preparation of supplies and equipment for laboratory experiences.	--	.05**	--	--

*Question numbers correspond to those on the questionnaire presented in Appendix B.

**Denotes items rated higher by science supervisors and teachers using commercial science curriculum materials than those using NSF sponsored science project materials. The converse is true for items not marked.

than do the two corresponding groups of elementary school personnel on items that pertain to developing local objectives of science education, developing criteria for selecting science curriculum materials, evaluating science curriculum materials, coordinating the science program through several grade levels, and conducting meetings to explain the local science program.

Professional groups using commercial science curriculum materials rated items 34 and 77 higher than those using NSF sponsored science project materials. All other items were rated higher by those using NSF sponsored science project materials.

Leadership

Few differences were found between the two professional groups at either the elementary or the secondary level as to the recommended behaviors of the science supervisor concerning leadership. However, numerous differences between these two professional groups were found at both the elementary and secondary school levels as to his actual leadership activities. Items describing science supervisory activities of initiating change or proposing change such as items 28, 47, and 48 were significant. Supervisory activities such as arranging for released time or extra pay for teachers to attend in-service meetings or to work with science-incentive programs were significant especially at the secondary school level.

All significant items pertaining to leadership were rated higher by professional groups using NSF science project materials than by those using commercial science curriculum materials.

In-Service Programs

The two professional groups differed on only four of the 15 items in this section. Elementary school personnel differed on only one item; secondary school personnel differed on three items. All four of these items were rated higher by professional groups using NSF sponsored science project materials than by those using commercial science curriculum materials.

Equipment-Materials

Significant differences were found between the two professional groups of elementary school personnel on items dealing with the science supervisory activities related to the storage of equipment and supplies, the supplementary facilities such as a laboratory table suitable for demonstrations, the equipment and supplies for demonstrations, and the preparation of supplies and equipment for laboratory experiences. All of these items were rated higher by elementary school personnel using commercial science curriculum materials than those using NSF sponsored science project materials.

The two professional groups of secondary school personnel differed on four items. All of these items were rated higher by professional groups using NSF sponsored science project materials than those using commercial science curriculum materials.

Null hypothesis 5 (Ho_5: $AB_{ele} = AB_{sec}$) was rejected for numerous items: 12 of the 18 curriculum items; 13 of the 17 leadership items; 11 of the 15 items which pertained to in-service programs; and 12 of the 14 items that concerned equipment - materials. Since the items for which the hypothesis was rejected are so numerous, they were not listed here, but a complete summary of chi square values is presented in Appendix G.

These findings clearly indicate numerous differences between elementary and secondary school personnel as to the perceived actual science supervisory activities. The findings support the original research design which stratified the population into elementary and secondary school personnel for the purposes of testing null hypotheses 3 and 4.

Intraclass and Rank Correlations

Spearman rank correlation coefficients were used to determine relationships between professional groups implementing NSF sponsored science project materials and those implementing commercial science curriculum materials in the areas of curriculum, leadership, in-service programs, and equipment-materials. In addition, the number of items which were significant through the chi square test were observed to determine relationships between these two professional groups. Intraclass correlation was used to determine the reliability of ratings within the groups using NSF sponsored science project and commercial science curriculum materials so that the rank correlation coefficients between these groups would be more meaningful.

In order to prevent differences between elementary and secondary school personnel from affecting these relationships the responses from the two professional groups were analyzed separately.

The intraclass correlations were calculated using the formulas developed by Ebel.[1,2] The result of the calculation is an estimation

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[1]Robert L. Ebel, "Estimation of the Reliability of Ratings", Psychrometrika, XVI (December, 1951), 407-424.

[2]J. P. Guilford, Psychrometric Methods (New York: McGraw-Hill Book Company, Inc., 1954), pp. 395-398.

of the reliability of ratings and can be interpreted as a measure of agreement. According to the intraclass correlations, then, as listed in Table 13, the groups of items in the areas of curriculum, leadership, in-service programs, and equipment-materials are of similar reliability. The intraclass correlations calculated from the responses of professional groups using commercial science curriculum materials are consistently higher than those calculated from the responses of professional groups using NSF sponsored science project materials. Those using commercial science curriculum materials, therefore, agree on the actual supervisory behaviors to a greater extent than those using NSF sponsored science project materials.

TABLE 13

RELATIONSHIP OF RESPONSES FROM SCIENCE SUPERVISORS AND TEACHERS USING NSF SPONSORED SCIENCE PROJECT MATERIALS AND THOSE USING COMMERCIAL SCIENCE CURRICULUM MATERIALS

Section of the Questionnaire	Intraclass Correlation		Spearman Rank Correlation	Ratio of Number of Significant Items
	NSF	Commercial		
Elementary				
Curriculum	0.592	0.734	0.882	4/18
Leadership	.623	.746	.972	5/17
In-Service	.697	.800	.824	1/15
Equipment-materials	.732	.818	.886	3/14
Secondary				
Curriculum	.578	.714	.913	8/18
Leadership	.607	.660	.941	8/17
In-Service	.623	.804	.951	3/15
Equipment-materials	.700	.798	.938	----

Rank correlation is a measure of agreement.[3] Since higher rank correlations were found between the two secondary school professional groups than between the two elementary school professional groups, the degree of agreement among secondary school personnel was greater than among elementary school personnel. The rank correlations in general were relatively high indicating general agreement between the two professional groups as to the rank order of items.

Although the two professional groups agree in general as to the rank order of items within the areas of curriculum, leadership, in-service programs, and equipment-materials, they differ on particular items as was shown by the number items for which hypothesis 3 (Ho_3: $AB_1 = AB_2$) was rejected on the basis of chi square values. This is illustrated in Table 13 by the ratio of the number of significant items to the total number of items within that particular area. For example, 4/18 means that four of the 18 items were significant in the area of curriculum.

Science Supervisory Behavior as Recommended by College Science Educators, Science Supervisors, and Teachers

The recommended behaviors of science supervisors in implementing science curriculum materials are perceived differently by college science educators than by science teachers or by science supervisors. For example, in the chi square test between the responses of science teachers and of college science educators, significant differences at the 0.05 level were found in 31 of the 64 items tested. Using the same test

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[3] Sidney Siegel, Nonparametric Statistics for the Behavioral Sciences (New York: McGraw-Hill Book Company, Inc., 1956), p. 202.

between the responses of science supervisors and of college science educators, significant differences were found in 21 of the 64 items tested. Complete summaries of chi square values are presented in Appendices H and I.

In Table 14, the level of significance indicates the items for which differences were found. Since the responses of college science educators were used in both analyses, the table was designed to make comparison of results convenient.

Curriculum

Fewer differences were found in the area of curriculum between college science educators and science supervisors than between college science educators and teachers. For example, college science educators and science supervisors differed on only two items while college science educators and teachers differed on six items.

In five of the six items college science educators perceived the science supervisor performing the recommended activities more frequently than did the teachers.

Leadership

Both science supervisors and teachers differed with college science educators concerning recommended supervisory practices in the area of leadership. Items such as 26, 47, and 48 which describe a dynamic role for the science supervisor tend to be significant. In addition, items concerning the science supervisor arranging extra pay for teachers who attend in-service meetings or who work on science-incentive programs were significant. Except for item 22, science supervisors or teachers rated each of the significant items higher than

TABLE 14

RECOMMENDED BEHAVIORS OF SCIENCE SUPERVISORS WHICH WERE PERCEIVED DIFFERENTLY BY COLLEGE SCIENCE EDUCATORS AND SCIENCE SUPERVISORS OR BY COLLEGE SCIENCE EDUCATORS AND TEACHERS

Questionnaire Item	Science Supervisors N = 464	Teachers N = 529
Curriculum		
The science supervisor:		
*29. gives support to teachers who try new curriculum materials.	--	0.05**
34. encourages teachers to use science demonstrations.	--	.01
37. encourages teachers to use individual laboratory experiences with pupils.	--	.01**
46. organizes committees for curriculum study.	.05	--
67. conducts parent meetings to explain the local science program.	--	.01**
74. encourages teachers to do research related to science instruction.	--	.05**
76. helps teachers design tests and use test results.	--	.001**
77. arranges for teachers to evaluate films, filmstrips and other instructional aids.	.05	--
Leadership		
The science supervisor:		
19. states his point of view with enthusiasm, reasoning and persuasion rather than with the use of authority.	.01	--
22. recommends teachers for committee chairmen and other leadership roles.	--	.05**

*Question numbers correspond to those on the questionnaire presented in Appendix B.

**Denotes items rated higher by college science educators than by science supervisors or by teachers. The converse is true for items not marked.

TABLE 14--Continued

Questionnaire Item	Science Supervisors	Teachers
*26. aids the teachers in improving classroom instruction and learning without a specific request for such aid.	.001	.01
47. identifies problems or weaknesses in the science program and discusses them with the teachers.	.05	--
48. proposes curriculum changes.	.001	--
49. serves as liaison with scientific and technical organizations and enlists the aid of their members in improving the science curriculum.	--	.01
58. arranges for extra pay for teachers who attend in-service meetings.	.001	.001
59. arranges for extra pay or reduced load for teachers who work with science-incentive programs.	.05	.01
61. teaches science classes at the request of the teacher.	.05	.001
73. reports to teachers after he attends a professional meeting.	.05	--
In-Service		
The science supervisor:		
24. observes classroom teaching-learning situations.	.05	.001**
25. visits the new teachers more often than he visits other teachers in the system.	.01	--
52. conducts in-service programs through the use of T.V., radio and/or motion picture film.	--	.05
54. makes use of the school laboratories as instructional centers for in-service education.	--	.001**

*Question numbers correspond to those on the questionnaire presented in Appendix B.

**Denotes items rated higher by college science educators than by science supervisors or by teachers. The converse is true for items not marked.

TABLE 14--Continued

Questionnaire Item	Science Supervisors	Teachers
*56. makes arrangements with a college or university to give college credit for in-service courses.	--	.001
60. observes the teaching of science and confers with the teacher concerning observations.	.01	.001**
62. arranges for teachers to observe class-room teaching and individual laboratory experiences guided by another teacher.	--	.05**
63. conducts or arranges for workshops or conferences in science content.	--	.05**
64. conducts or arranges for workshops or conferences in the effective use of instructional materials.	--	.05**
66. secures the teacher's evaluation of the in-service programs.	--	.001**
68. obtains consultants who conduct in-service activities.	--	.05**
Equipment-Materials		
The science supervisor:		
30. assists in plans for constructing or remodeling science laboratories or science facilities.	.05	.05**
32. arranges for equipment and supplies appropriate for the curriculum being used.	.001	.001
33. coordinates the use of equipment from central storage.	--	.001
35. arranges for supplementary facilities such as a portable laboratory table or a demonstration table suitable for pupil and teacher demonstrations.	--	.05

*Question numbers correspond to those on the questionnaire presented in Appendix B.

**Denotes items rated higher by college science educators than by science supervisors or by teachers. The converse is true for items not marked.

TABLE 14--Continued

Questionnaire Item	Science Supervisors	Teachers
*36. arranges for equipment and supplies for science demonstrations.	.01	.001
38. arranges for adequate science facilities and furniture suitable for experimentation by pupils.	.05	--
39. arranges for equipment and supplies in necessary quantities for sufficient individual pupil laboratory experiences.	.001	.001
78. meets with teachers to plan for changes in equipment, supplies, and resources to correspond to changes in the curriculum.	.05	--
80. aids teachers in arranging storage of laboratory equipment and supplies.	.001	.01
81. aids teachers in systematizing the preparation of supplies and equipment for laboratory experiences.	--	.05
82. provides assistance to teachers in the repair and maintenance of equipment.	.001	.001

*Question numbers correspond to those on the questionnaire presented in Appendix B.

**Denotes items rated higher by college science educators than by science supervisors or by teachers. The converse is true for items not marked.

did the college science educators.

In-Service

Teachers differed with college science educators more than science supervisors concerning in-service programs. Science supervisors and college science educators differed on only three items whereas science teachers and college science educators differed on 10 items. Those items for which there were significant differences between science supervisors and college science educators were rated higher by science supervisors while those items for which significant differences were found between teachers and college science educators were rated higher by the college science educators except items 52 and 56.

Equipment-Materials

Many items related to equipment-materials were significant. All significant items except item 30 were rated higher by science supervisors or teachers than by college science educators.

Summary

Science supervisors and teachers using National Science Foundation sponsored science project materials differ from those using commercial science curriculum materials as to the perceived:

1. relative importance of characteristics of science curriculum materials;
2. relative importance of objectives of science education;
3. actual behaviors of science supervisors, and
4. recommended behaviors of science supervisors.

In addition, elementary school personnel perceived the role of the science supervisor differently than did secondary school personnel. According to intraclass correlations science supervisors and teachers using commercial science curriculum materials agree on the actual science supervisory behavior to a greater extent than those using NSF sponsored science project materials.

Rank correlation coefficients indicate relatively high agreement concerning actual science supervisory activities in curriculum, leadership, in-service, and equipment-materials between science supervisors and teachers using NSF sponsored science project materials and those using commercial science curriculum materials. The degree of agreement among secondary school personnel was greater than among elementary school personnel. The recommended behaviors of science supervisors as perceived by college science educators differ from those perceived by science supervisors. The recommended behaviors of science supervisors as perceived by college science educators differ from those perceived by elementary and secondary school teachers.

A more complete summary indicating the professional group that rated particular items higher is delineated in Chapter V.

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of this study was to determine and analyze the role of the science supervisor in the selection and use of science curriculum materials as perceived by science supervisors and teachers involved in the implementation of programs utilizing: (1) the National Science Foundation (NSF) sponsored science project materials, and (2) commercial science curriculum materials.

Specifically, the problem had two parts. Part I dealt with the relative importance of characteristics of science curriculum materials and of the objectives of science education in selecting science curriculum materials as perceived by the above two professional groups. Part II pertained to the actual and recommended behaviors of the science supervisor in implementing science curriculum materials as perceived by these two groups.

A two-part questionnaire structured to obtain responses on a five-point scale was designed, pretested, revised, and mailed to a national sample of science supervisors and teachers who were involved in the implementation of NSF sponsored and commercial science curriculum materials. Questions in Part I of the questionnaire were concerned with the relative importance of characteristics of science curriculum materials and Part II with the relative frequency of those science supervisory activities directly related to the implementation of science curriculum materials, namely: curriculum, leadership, in-service programs, and equipment-materials.

Questionnaires were mailed to respondents in the fall and winter of 1965 and the percentages of returns were: 68.4 of the science supervisors, 62.2 of the college science educators and 69.0 of the teachers.

An International Business Machines (IBM) response sheet was used with the mailed questionnaire as the method of collecting data. Data processing cards were punched directly from the response sheets with mark sensing equipment, and the statistical analysis was achieved through the use of the Control Data Corporation 3600 Computer. The analyses included the use of chi square, means, percentage, intraclass correlation, and Spearman rank correlation.

Summary of Findings

Personal Information

Science supervisors in the United States are usually employed by a local school district or system. They usually devote 50 or more percent of their regular working hours to science supervision. The number of teachers under their supervision varies greatly and they may have from one to three assistants who also have supervisory responsibilities; however, 76.8 percent of the science supervisors have no assistants.

Nearly all science supervisors have the responsibility of selecting and implementing science curriculum materials, organizing and maintaining adequate in-service programs, and selecting equipment and supplies and supervising their use. These science supervisors experienced most of their full-time classroom teaching at the secondary school level. Many of them, however, have supervisory responsibility at the elementary school level.

Science supervisors usually have a master's degree, are educators of 41 or more years of age, have more than 10 years of classroom experience, and have supervised science for at least four years. The academic training of science supervisors varies greatly. For example, the questionnaire data revealed that 9.3 percent of the science supervisors in chemistry, 4.4 percent in physics, 17.8 percent in biological science, 0.8 percent in earth science, and 2.0 percent in mathematics held 51 or more semester hours of college credit in these respective fields.

Selection of Science Curriculum Materials

The findings indicate differences between professional groups using NSF sponsored science project materials and those using commercial science curriculum materials. An analysis of response frequencies within contingency tables of questionnaire items in which the null hypothesis 1 (Ho_1: $CM_1 = CM_2$) was rejected indicates that the professional groups using commercial science curriculum materials place greater importance on those materials which emphasize: (1) teacher demonstrations, (2) science content units, (3) qualitative observations and explanations, (4) science facts and principles, and (5) explanations to develop concepts. A similar analysis of the items in which the null hypothesis 2 (Ho_2: $Obj_1 = Obj_2$) was rejected indicates that the professional groups using NSF sponsored science project materials consider those materials to be of greater importance which emphasize: (1) the individual laboratory approach to teaching and learning, (2) the use of laboratory experiences as the primary source of information, (3) the elements of scientific methods, (4) the quantitative approach to science education, (5) the investigative approach to concept development, and (6) tests that measure the child's ability to use the methods of scientific inquiry.

The items designed to test null hypothesis 2 were derived directly from objectives of science education. Therefore, differences observed between professional groups using NSF sponsored science project materials and those using commercial science curriculum materials also indicate differences in their interpretations of the objectives of science education.

Actual Behavior of Science Supervisors

Comparisons were made of response frequencies from elementary and secondary school science supervisors and teachers using NSF sponsored science project materials and from those using commercial science curriculum materials on significant questionnaire items designed to test null hypotheses 3 (Ho_3: $AB_1 = AB_2$). Both elementary and secondary school personnel indicate that:

A. Science supervisors using commercial science curriculum materials more frequently encourage teachers to use science demonstrations.

B. Science supervisors using NSF sponsored science project materials more frequently

1. support teachers who try new curriculum materials;
2. encourage teachers to use individual laboratory experiences with pupils;
3. encourage teachers to experiment with new ideas and practices in teaching science;
4. arrange for released time to enable teachers to attend in-service programs;

5. report to teachers after they attend a professional meeting; and
6. are actively involved in educational research.

In similar comparisons for only the elementary school area, the responses show that:

A. Science supervisors using commercial science curriculum materials more frequently
    1. arrange for teachers to evaluate films, filmstrips, and other instructional aids;
    2. coordinate the use of equipment from central storage;
    3. arrange for supplementary facilities such as a portable laboratory table or a demonstration table suitable for pupil and teacher demonstrations; and
    4. aid teachers in arranging storage of laboratory equipment and supplies.

B. Science supervisors using NSF sponsored science project materials more frequently
    1. identify problems or weaknesses in the science program and discuss them with the teachers; and
    2. secure the teacher's evaluation of the in-service programs.

Similar comparisons of responses from secondary science supervisors and teachers indicate that science supervisors using NSF sponsored science project materials more frequently:

1. encourage advanced and/or individual study programs for pupils interested in further opportunities in science;
2. work as an active member of committees or groups in

determining local objectives of science education;

3. meet with teachers to evaluate current curriculum materials on the basis of developed criteria;
4. conduct meetings to coordinate the science program through several grade levels;
5. conduct parent meetings to explain the local science program;
6. recommend teachers for committee chairmanship and other leadership roles;
7. propose curriculum changes;
8. arrange for extra pay for teachers who attend in-service meetings;
9. arrange for extra pay or reduced load for teachers who work with science-incentive programs;
10. arrange for in-service programs that are directly related to the curriculum used with pupils;
11. make arrangements with a college or university to give college credit for in-service courses; and
12. make use of the school laboratories as instructional centers for in-service education.

Elementary and secondary school personnel perceive the actual behaviors of science supervisors differently. Using the chi square test at the 0.05 level, hypothesis 5 (Ho_5: $AB_{ele} = AB_{sec}$) was rejected for 48 of the 64 items tested. The number of significant items within each of the four sections of the questionnaire were: 12 of the 18 curriculum items; 13 of the 17 leadership items; 11 of the 15 items which pertained to in-service programs; and 12 of the 14 items that concerned equipment-materials.

Recommended Behaviors of Science Supervisors

A study of the contingency tables resulting from the calculation of chi square values of questionnaire items designed to test null hypothesis 4 (Ho_4: $RB_1 = RB_2$) reveals which professional group rated particular items higher. A comparison of the recommended science supervisory behaviors by elementary school science supervisors and teachers using NSF sponsored science project materials with those using commercial science curriculum materials indicates that:

A. Elementary school science supervisors and teachers using commercial science curriculum materials recommend that the science supervisor should more frequently

1. encourage teachers to use science demonstrations;
2. arrange for equipment and supplies for science demonstrations; and
3. aid teachers in systematizing the preparation of supplies and equipment for laboratory experiences.

B. Elementary school science supervisors and teachers using NSF sponsored science project materials recommend that the science supervisor should more frequently

1. support teachers who try new curriculum materials; and
2. encourage teachers to use individual laboratory experiences with pupils.

A similar comparison of the recommended science supervisory behaviors of secondary school science supervisors and teachers using NSF sponsored science project materials with those using commercial science curriculum materials reveals that:

A. Secondary science supervisors and teachers implementing commercial science curriculum materials recommend that the science supervisor should more frequently encourage teachers to use science demonstrations.

B. Secondary science supervisors and teachers implementing NSF sponsored science project materials recommend that the science supervisor should more frequently

1. support teachers who try new curriculum materials;
2. encourage advanced and/or individual study programs for pupils interested in further opportunities in science;
3. meet with teachers to develop criteria for selecting science curriculum materials;
4. conduct parent meetings to explain the local science program;
5. become involved in educational research;
6. make use of the school laboratories as instructional centers for in-service education;
7. arrange for adequate science facilities and furniture suitable for experimentation by pupils;
8. arrange for equipment and supplies in necessary quantities for sufficient individual pupil laboratory experiences;
9. meet with teachers to plan for changes in equipment, supplies, and resources to correspond to changes in the curriculum; and
10. meet with teachers to establish standards of selection and procurement of science equipment and supplies.

The recommended behaviors of science supervisors in using science curriculum materials were viewed differently by college science educators, by teachers and by science supervisors. For example, in the chi square test, significant differences between college science educators and teachers at the 0.05 level were found in 31 of the 64 items tested. The number of significant items within each of the four sections of the questionnaire were: six of the 18 curriculum items, six of the 17 leadership items, 10 of the 15 items which pertained to in-service programs, and nine of the 14 items that concerned equipment-materials. For the same test significant differences between science supervisors and college science educators were found in 21 of the 64 items tested. The number of significant items within each section of the questionnaire were: two of the 18 curriculum items, eight of the 17 leadership items, three of the 15 items which pertained to in-service programs, and eight of the 14 items that concerned equipment-materials. Complete summaries of chi square values are presented in Appendices H and I. Items found to be significant are listed in Table 14.

Conclusions

The conclusions based on the analyses of responses from science supervisors, teachers, and college science educators indicate that:

A. Science supervisors and teachers using National Science Foundation (NSF) sponsored science project materials differ from those using commercial science curriculum materials as to the perceived relative importance of particular characteristics of science curriculum materials and to the perceived relative importance of selected objectives of science

education.

1. These two groups of science supervisors and teachers differ as to the relative importance of teacher demonstrations, the individual laboratory approach to teaching and learning, science facts and principles in science education, the elements of scientific methods, explanations to develop concepts, and the investigative approach to concept development.

2. Science supervisors and teachers using NSF sponsored science project materials place greater relative importance on selected objectives of science education as developed for this study than those using commercial science curriculum materials.

B. Science supervisors and teachers using NSF sponsored science project materials differ from those using commercial science curriculum materials as to the perceived actual behavior of science supervisors.

1. Many differences between these two groups of science supervisors and teachers are apparently related to the elements of scientific methods and the individual laboratory or the investigative approach to the teaching and learning of science.

2. Science supervisors implementing NSF sponsored science project materials assume a more dynamic leadership role than those implementing commercial science curriculum materials.

3. Science supervisors and teachers using commercial science

curriculum materials agree on the actual supervisory behaviors to a greater extent than those using NSF sponsored science project materials. Also, the degree of agreement among secondary school personnel was greater than among elementary school personnel.

C. Science supervisors and teachers using NSF sponsored science project materials differ from those using commercial science curriculum materials as to recommended behaviors of science supervisors.

   1. The two groups of science supervisors and teachers differ less concerning recommended supervisory behaviors than they do regarding actual supervisory practices.

   2. Differences between the two groups of science supervisors and teachers concerning recommended supervisory behaviors were related to encouraging teachers to use science demonstrations or individual laboratory experiences with pupils.

D. The perceived actual behaviors of science supervisors of grades K-6 differ from the perceived actual behaviors of science supervisors of grades 7-12.

E. Science supervisors and teachers using NSF sponsored science project materials do not differ from those using commercial science curriculum materials in relation to age; professional experience; highest degree held; and academic training in science, mathematics, and methods of teaching science. The above differences, therefore, cannot be attributed to these factors.

F. The recommended behaviors of science supervisors are viewed differently by: college science educators and teachers; college science educators and science supervisors. A comparison of response frequencies on significant questionnaire items indicates that both science supervisors and teachers perceived a more directive leadership role of the science supervisor than college science educators.

Implications for Future Research

Many unanswered questions could be composed regarding the variables explored in this study in relation to the role of the science supervisor. Some of these questions are comprehensive and should provide direction for continued research in science supervision.

1. What are the effects of specific science supervisory practices upon the quality of teaching and upon pupil achievement?
2. Is the dynamic leadership role of the science supervisor more effective in initiating change than a more passive role?
3. What are the techniques and practices of those science supervisors who have developed outstanding science programs?
4. Are there significant changes in the quality of teaching and learning within those school districts that have recently employed science supervisors?
5. What are the differences between the supervisory practices of first-year science supervisors and those who

have been science supervisors for at least three years?

6. Is there a relationship between the quality of supervision and the number of teachers assigned to one supervisor?
7. Does the interpretation of objectives of science education determine the types of science curriculum materials that science supervisors and teachers select?
8. Do the types of science curriculum materials that science supervisors and teachers are implementing affect their interpretation of objectives of science education?
9. Is there a relationship between the science supervisor's concept of democratic supervision and his supervisory practices?
10. Do science supervisors who are dynamic leaders tend to select NSF sponsored science project materials or does the act of implementing a new and different program cause them to assume a more dynamic leadership role?

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APPENDICES

APPENDIX A

MICHIGAN STATE UNIVERSITY EAST LANSING

SCIENCE AND MATHEMATICS TEACHING CENTER

Science curriculum materials are being changed rapidly today by those associated with commercial publishers and projects sponsored by the National Science Foundation. Science supervisors have the responsibility of selecting and implementing these widely different programs. However, few guidelines have been established through research concerning what the science supervisor does or ought to do in fulfilling this responsibility.

Since science supervisors are being employed at an ever increasing rate in this country, it is important that their role be determined as accurately and as quickly as possible. To aid in determining the role of the science supervisor, this study is being conducted in cooperation with the National Science Supervisors Association and its Commission on the Role of the Science Supervisor; the study is under the direction of Dr. Wayne Taylor utilizing the services of the Michigan State University Bureau of Educational Research.

The purpose of this study is to determine and analyze the role of the science supervisor in the selection and use of both commercial and National Science Foundation sponsored science curriculum project materials. For the study to yield valid information, all forms must be returned by science supervisors, science educators, and teachers. Your cooperation in responding is vital.

Your participation would consist of completing the enclosed questionnaire and returning the response sheet together with the personal information form by November 24, 1965. You may keep the questionnaire for your files. A summary of the findings will be sent to those who return the completed forms with their names and addresses.

We know that there are many demands on your time and we hesitate to introduce an additional task to your busy schedule. However, the information sought is extremely important to our profession and only professional personnel can furnish this information.

Thank you for your cooperation.

Sincerely,

Glenn D. Berkheimer
Graduate Research Assistant

GDB:css

Enclosure

MICHIGAN STATE UNIVERSITY EAST LANSING · MICHIGAN 48823

SCIENCE AND MATHEMATICS TEACHING CENTER · HOLMES HALL

December 29, 1965

Dear Teacher:

Science curriculum materials are being changed rapidly today by those associated with commercial publishers and projects sponsored by the National Science Foundation. Science supervisors have the responsibility of selecting and implementing these widely different programs. However, few guidelines have been established through research concerning what the science supervisor does or ought to do in fulfilling this responsibility.

Since science supervisors are being employed at an ever increasing rate in this country, it is important that their role be determined as accurately and as quickly as possible. To aid in determining the role of the science supervisor, this study is being conducted in cooperation with the National Science Supervisors Association and its Commission on the Role of the Science Supervisor. The study is under the direction of Dr. Wayne Taylor and utilizes the services of the Michigan State University Computer Center to obtain the maximum information from responses.

The purpose of this study is to determine and analyze the role of the science supervisor in the selection and use of both commercial and National Science Foundation sponsored science curriculum project materials. For the study to yield valid information, all forms must be returned. Your cooperation in responding is vital.

Your participation would consist of completing the enclosed questionnaire and returning the response sheet together with the personal information form by January 28, 1966. You may keep the questionnaire for your files. A summary of the findings will be sent to those who return the completed forms with their names and addresses.

We know that there are many demands on your time and we hesitate to introduce an additional task to your busy schedule. However, the information sought is extremely important to our profession and only professional personnel can furnish this information.

Thank you for your cooperation.

Sincerely,

Glenn D. Berkheimer
Graduate Research Assistant

GDB:ff

Enclosure

STATE OF MICHIGAN

DEPARTMENT OF EDUCATION

Lansing, Michigan 48902

ALEXANDER J. KLOSTER
Acting Superintendent of Public Instruction

October 28, 1965

Dear Science Supervisor and/or Educator:

I have reviewed the research study being conducted by Dr. Wayne Taylor and Mr. Glenn Berkheimer of Michigan State University, and wholeheartedly endorse it for your participation. This study should have both local and national significance.

The purpose of the study is a vital one for the improvement of science education. It deals with one phase of the role of science supervisory leadership, i. e., the role of a science supervisor in relation to the selection and use of curriculum materials for science education.

How this particular role is played can have a great impact on closing the gap between the nature of science, and the nature of science education. Curriculum materials selection is a great determining factor in the "what and why" of any local school science program. For these plus many other reasons, I consider it important to seek clues as to how this role is currently perceived and what kind of model persons think it should be.

Again, I recommend this study for your consideration and active participation.

Sincerely,

Alexander J. Kloster

Alexander J. Kloster
Acting Superintendent
of Public Instruction

APPENDIX B

QUESTIONNAIRE ON THE SCIENCE SUPERVISORS' ROLE IN THE SELECTION AND USE OF SCIENCE CURRICULUM MATERIALS

by

Science and Mathematics Teaching Center
Michigan State University
Dr. Wayne Taylor
Glenn D. Berkheimer

INSTRUCTIONS: Please check over the questionnaire to get an idea of the scope of questions asked before beginning to fill out the form, then follow the directions of each part and respond to each question. Since the Control Data Corporation 3600 Computer will be used in the analysis of the data, a separate response sheet is included to facilitate machine tabulation of the responses. Please use the enclosed number two pencil for marking your responses.

RETURN THE RESPONSE SHEET AND THE PERSONAL INFORMATION FORM IN THE ENCLOSED STAMPED ENVELOPE.
You may keep the questionnaire for your files.

HANDLING OF INFORMATION: Since responses will be machine tabulated and no individuals or schools will be identified in the study reports, the confidential nature of the information will be preserved. Please use complete candor in your reactions so that the critical analysis of practices will be of maximum use to the profession.

QUESTIONNAIRE, PART I

DIRECTIONS: The numbers in the scale represent your reaction to the statements with increasing importance. Please select the number that most nearly represents your professional opinion and mark the corresponding number on the response sheet. Note the selection of zero (0) indicates that you prefer not to express an opinion.

The scale is defined as:

0--no opinion

1--little or no importance

2--some importance

3--very important

4--essential

IN SELECTING SCIENCE CURRICULUM MATERIALS, HOW IMPORTANT DO YOU CONSIDER:

0,1,2,3,4 1. materials that place major emphasis on the individual laboratory approach to teaching and learning.

0,1,2,3,4 2. materials that place major emphasis on teacher demonstrations or group experiences.

0,1,2,3,4 3. materials that use laboratory experiences as the primary source of information.

0,1,2,3,4 4. materials that use a wide variety of books and references as the primary source of information.

0,1,2,3,4 5. materials that place major emphasis on science content topics such as weather, machines, electricity, magnetism, etc.

0,1,2,3,4 6. materials that place major emphasis on learning how to observe, to form hypotheses, to design experiments and to draw valid conclusions.

0,1,2,3,4 7. materials that include an extensive teachers' guide so that the need for local curriculum guides are minimized.

0,1,2,3,4 8. materials that are composed of units so that they can be ordered and/or selected through the use of a locally designed curriculum guide.

0,1,2,3,4 9. materials that emphasize using quantitative observations and mathematics to study relations.

0,1,2,3,4 10. materials that place major emphasis on qualitative observations and explanations.

0,1,2,3,4 11. materials that place major emphasis on facts and science principles.

0,1,2,3,4 12. materials that place major emphasis on science concepts and theories.

0,1,2,3,4 13. materials that place major emphasis on the practical and useful nature of science such as explanations of how mechanical devices work.

0,1,2,3,4 14. materials that place major emphasis on the theoretical nature of science.

0,1,2,3,4 15. materials that place major emphasis on the investigative approach to concept development.

0,1,2,3,4 16. materials that emphasize explanations to develop concepts.

0,1,2,3,4 17. tests that measure the child's understanding of science principles and knowledge of related facts.

0,1,2,3,4 18. tests that measure the child's ability to use the methods of scientific inquiry.

QUESTIONNAIRE, PART II

DIRECTIONS: Please indicate your response to each question or statement twice. Indicate the degree to which the science supervisor:

1. actually performs the described behavior by selecting the number in the left column that most nearly represents the frequency with which the behavior actually occurs and by marking the corresponding number on the response sheet. (If you are a science supervisor, actual behavior refers to what you do.)

2. ought to perform the described behavior by selecting the number in the right column that most nearly represents the frequency with which the behavior ought to occur ideally and by marking the corresponding number on the response sheet.

The scale is defined as:

Actual Behavior		Recommended Behavior
0	I do not know	5
1	Almost never	6
2	Infrequently	7
3	Frequently	8
4	Very frequently	9

The terms almost never, infrequently, frequently and very frequently refer to the degree to which the science supervisor actually exhibits such behavior (LEFT column) or ought to exhibit such behavior (RIGHT column). The numbers in the columns represent these terms and not the specific number of times of occurence.

THE SCIENCE SUPERVISOR:

Actual Behavior			Recommended Behavior
0,1,2,3,4	19.	states his point of view with enthusiasm, reasoning, and persuasion rather than with the use of authority.	5,6,7,8,9
0,1,2,3,4	20.	respects and accepts the contribution of each staff member.	5,6,7,8,9
0,1,2,3,4	21.	respects and implements the conclusions of the committee or group even when they are counter to his own inclinations.	5,6,7,8,9
0,1,2,3,4	22.	recommends teachers for committee chairmen and other leadership roles.	5,6,7,8,9
0,1,2,3,4	23.	is an instructor in the in-service program.	5,6,7,8,9
0,1,2,3,4	24.	observes classroom teaching-learning situations.	5,6,7,8,9
0,1,2,3,4	25.	visits the new teachers more often than he visits other teachers in the system.	5,6,7,8,9
0,1,2,3,4	26.	aids the teacher in improving classroom instruction and learning without a specific request for such aid.	5,6,7,8,9
0,1,2,3,4	27.	helps maintain a science instructional materials center.	5,6,7,8,9

The scale is defined as:		
Actual Behavior		Recommended Behavior
0	I do not know	5
1	Almost never	6
2	Infrequently	7
3	Frequently	8
4	Very frequently	9

THE SCIENCE SUPERVISOR:

Actual Behavior			Recommended Behavior
0,1,2,3,4	28.	encourages teachers to experiment with new ideas and practices in teaching science.	5,6,7,8,9
0,1,2,3,4	29.	gives support to teachers who try new curriculum materials.	5,6,7,8,9
0,1,2,3,4	30.	assists in plans for constructing or remodeling science laboratories or science facilities.	5,6,7,8,9
0,1,2,3,4	31.	works with the administration to obtain an adequate budget for equipment and supplies.	5,6,7,8,9
0,1,2,3,4	32.	arranges for equipment and supplies appropriate for the curriculum being used.	5,6,7,8,9
0,1,2,3,4	33.	coordinates the use of equipment from central storage.	5,6,7,8,9
0,1,2,3,4	34.	encourages teachers to use science demonstrations.	5,6,7,8,9
0,1,2,3,4	35.	arranges for supplementary facilities such as a portable laboratory table or a demonstration table suitable for pupil and teacher demonstrations.	5,6,7,8,9
0,1,2,3,4	36.	arranges for equipment and supplies for science demonstrations.	5,6,7,8,9
0,1,2,3,4	37.	encourages teachers to use individual laboratory experiences with pupils.	5,6,7,8,9
0,1,2,3,4	38.	arranges for adequate science facilities and furniture suitable for experimentation by pupils.	5,6,7,8,9
0,1,2,3,4	39.	arranges for equipment and supplies in necessary quantities for sufficient individual pupil laboratory experiences.	5,6,7,8,9
0,1,2,3,4	40.	encourages teachers to promote science clubs and science fair activities.	5,6,7,8,9
0,1,2,3,4	41.	encourages advanced and/or individual study programs for pupils interested in further opportunities in science.	5,6,7,8,9
0,1,2,3,4	42.	encourages individual project activity as a regular part of science courses.	5,6,7,8,9
0,1,2,3,4	43.	works as an active member of committees or groups in determining local objectives of science education.	5,6,7,8,9
0,1,2,3,4	44.	meets with teachers to develop criteria for selecting science curriculum materials.	5,6,7,8,9
0,1,2,3,4	45.	meets with teachers to evaluate current curriculum materials on the basis of developed criteria.	5,6,7,8,9

The scale is defined as:

Actual Behavior		Recommended Behavior
0	I do not know	5
1	Almost never	6
2	Infrequently	7
3	Frequently	8
4	Very frequently	9

THE SCIENCE SUPERVISOR:

Actual Behavior			Recommended Behavior
0,1,2,3,4	46.	organizes committees for curriculum study.	5,6,7,8,9
0,1,2,3,4	47.	identifies problems or weaknesses in the science program and discusses them with the teachers.	5,6,7,8,9
0,1,2,3,4	48.	proposes curriculum changes.	5,6,7,8,9
0,1,2,3,4	49.	serves as liaison with scientific and technical organizations and enlists the aid of their members in improving the science curriculum.	5,6,7,8,9
0,1,2,3,4	50.	conducts meetings to coordinate the science program through several grade levels.	5,6,7,8,9
0,1,2,3,4	51.	arranges for in-service programs that are directly related to the curriculum used with the pupils.	5,6,7,8,9
0,1,2,3,4	52.	conducts in-service programs through the use of T.V., radio and/or motion picture film.	5,6,7,8,9
0,1,2,3,4	53.	arranges for demonstration lessons to illustrate recommended methods of teaching science.	5,6,7,8,9
0,1,2,3,4	54.	makes use of the school laboratories as instructional centers for in-service education.	5,6,7,8,9
0,1,2,3,4	55.	conducts in-service meetings on the effective use of equipment and supplies.	5,6,7,8,9
0,1,2,3,4	56.	makes arrangements with a college or university to give college credit for in-service courses.	5,6,7,8,9
0,1,2,3,4	57.	arranges for released time to enable teachers to attend in-service programs.	5,6,7,8,9
0,1,2,3,4	58.	arranges for extra pay for teachers who attend in-service meetings.	5,6,7,8,9
0,1,2,3,4	59.	arranges for extra pay or reduced load for teachers who work with science-incentive programs.	5,6,7,8,9
0,1,2,3,4	60.	observes the teaching of science and confers with the teacher concerning observations.	5,6,7,8,9
0,1,2,3,4	61.	teaches science classes at the request of the teacher.	5,6,7,8,9
0,1,2,3,4	62.	arranges for teachers to observe classroom teaching and individual laboratory experiences guided by another teacher.	5,6,7,8,9
0,1,2,3,4	63.	conducts or arranges for workshops or conferences in science content.	5,6,7,8,9
0,1,2,3,4	64.	conducts or arranges for workshops or conferences in the effective use of instructional materials.	5,6,7,8,9

The scale is defined as:

Actual Behavior		Recommended Behavior
0	I do not know	5
1	Almost never	6
2	Infrequently	7
3	Frequently	8
4	Very frequently	9

THE SCIENCE SUPERVISOR:

Actual Behavior			Recommended Behavior
0,1,2,3,4	65.	conducts or arranges for workshops or conferences on the effective use of equipment and supplies in the teaching of science.	5,6,7,8,9
0,1,2,3,4	66.	secures the teacher's evaluation of the in-service programs.	5,6,7,8,9
0,1,2,3,4	67.	conducts parent meetings to explain the local science program.	5,6,7,8,9
0,1,2,3,4	68.	obtains consultants who conduct in-service activities.	5,6,7,8,9
0,1,2,3,4	69.	arranges for consultant help in the selection of science curriculum materials.	5,6,7,8,9
0,1,2,3,4	70.	selects specific articles from the professional literature and recommends them to teachers.	5,6,7,8,9
0,1,2,3,4	71.	collects, analyzes and interprets research findings in science education and informs the teachers of pertinent conclusions drawn from this research.	5,6,7,8,9
0,1,2,3,4	72.	provides or writes a newsletter or bulletin to inform teachers of new developments in science education.	5,6,7,8,9
0,1,2,3,4	73.	reports to teachers after he attends a professional meeting.	5,6,7,8,9
0,1,2,3,4	74.	encourages teachers to do research related to science instruction.	5,6,7,8,9
0,1,2,3,4	75.	is actively involved in educational research.	5,6,7,8,9
0,1,2,3,4	76.	helps teachers design tests and use test results.	5,6,7,8,9
0,1,2,3,4	77.	arranges for teachers to evaluate films, filmstrips and other instructional aids.	5,6,7,8,9
0,1,2,3,4	78.	meets with teachers to plan for changes in equipment, supplies, and resources to correspond to changes in the curriculum.	5,6,7,8,9
0,1,2,3,4	79.	meets with teachers to establish standards of selection and procurement of science equipment and supplies.	5,6,7,8,9
0,1,2,3,4	80.	aids teachers in arranging storage of laboratory equipment and supplies.	5,6,7,8,9
0,1,2,3,4	81.	aids teachers in systematizing the preparation of supplies and equipment for laboratory experiences.	5,6,7,8,9
0,1,2,3,4	82.	provides assistance to teachers in the repair and maintenance of equipment.	5,6,7,8,9

PERSONAL INFORMATION

Name________________________________ Title______________

Institutional Affiliation______________________________________

Street______________________________ Phone______________

City________________________________ State______________

DIRECTIONS: Please answer the following questions by checking the appropriate boxes.

A. Are you a science supervisor?

For the purposes of this study, science supervisor is used to denote a person to whom responsibility has been delegated for the supervision, leadership, and improvement of the elementary and/or secondary school science program and who devotes a portion of his regular working time fulfilling this responsibility. Various titles are used for this position, but the title is not important so long as he is given this responsibility and is actively carrying out that responsibility. For example, the term science supervisor could include persons with titles such as science consultant, science coordinator, etc.

☐ YES (if yes, proceed to section C)

☐ NO (if no, complete section B, disregard section C, proceed to PART II of the questionnaire, and complete only the Recommended Behavior column.)

Section B

Which category most nearly describes your position?

☐ teacher or instructor at the college level

☐ college or university administrator

☐ chairman, secondary school science department

☐ secondary school teacher

☐ secondary school administrator

☐ elementary school teacher

☐ elementary school administrator

☐ other (please specify)______________

Section C

PERSONAL INFORMATION -- Science Supervisor

1. You are employed by:

☐ a school district or system

☐ a state department

☐ a county department

☐ other (please specify)______________

2. What portion of your regular working hours do you serve as a science supervisor?

☐ 0-10%; ☐ 11-25%; ☐ 26-50%
☐ 51-75%; ☐ 76-100%

3. You are a science supervisor of what grade levels? (Check one only.)

☐ K-12; ☐ K-8; ☐ K-6;
☐ 7-12; ☐ 9-12; ☐ 7-9;
☐ 4-6; ☐ other (specify)________

Section "C" Continued

4. How many teachers are under your supervision?

A. ☐ less than 50; ☐ 51-100;
☐ 101-150; ☐ 151-250; ☐ 251-350;
☐ 351-451; ☐ If more than 451, specify__________.

B. ______teachers of grades, K-6. (please specify)

______secondary biology teachers. (please specify)

5. If additional questionnaires were mailed to you, would you be willing to distribute them to several elementary teachers and/or to several secondary biology teachers? (These teachers would be selected by number from your response in question 4B.)

☐ YES ☐ NO

6. ELEMENTARY. Indicate the percentage of elementary school classes using the listed science curriculum materials in the school system or systems in which you have supervisory responsibility.

_____% Allyn and Bacon Science Series by Thurber.

_____% American Book Co. Science Series by Jacobson, Lauby, and Konicek.

_____% D. C. Heath and Co. by Herman and Nina Schneider.

_____% Elementary Science Study by Educational Services, Inc. (Houghton Mifflin Co.)

_____% Elementary School Science Curriculum Materials by the AAAS Commission on Science Education.

_____% Elementary School Science Project Materials, University of Illinois, Co-directors: Atkin and Wyatt.

_____% Harper & Row, Publishers Science Series by Navarra & Zafforoni.

_____% Macmillan Science Series by Barnard, Stendler, Spock, and others.

_____% Other (specify)______________

____

100 % Total

7. SECONDARY SCHOOL BIOLOGY. Indicate the percentage of biology classes using the listed science curriculum materials in the school system or systems in which you have supervisory responsibility.

_____% BSCS Green Version: High School Biology, Rand McNally Company.

_____% Biological Science: An Inquiry Into Life (BSCS-Yellow Version), Harcourt, Brace, and World Company.

_____% Biological Science: Molecules to Man (BSCS-Blue Version), Houghton Mifflin Company.

_____% Exploring Biology: The Science of Living Things by Ella Thea Smith.

_____% Modern Biology by Moon, Otto, Towle.

_____% Other (specify)______________

____

100 % Total

Do you have the major responsibility for leadership in:

	YES	NO
8. selecting science curriculum materials?		
9. implementing science curriculum materials?		
10. organizing and maintaining an adequate in-service program?		
11. selecting and supervising the use of equipment and supplies?		

12. How many assistants who have supervisory responsibility are assigned under your direction?

☐ 0; ☐ 1; ☐ 2; ☐ 3; ☐ 4;
☐ 5; ☐ If more than 5, specify __________.

Section "C" Continued

13. At what grade levels have you been a full time classroom teacher?

☐ K-3; ☐ 4-6; ☐ 7; ☐ 8; ☐ 9;
☐ 10; ☐ 11; ☐ 12; ☐ college

14. Highest degree held:

☐ Bachelors; ☐ Masters; ☐ Doctorate

15. Sex: ☐ Male; ☐ Female;

16. Age in years:

☐ less than 30; ☐ 31-40; ☐ 41-50;
☐ more than 50

Number of years of professional experience (Count this year):	1	2	3	4-6	7-10	more than 10
17. As a science teacher - - - - - - - -						
18. As a science supervisor- - - - - - -						
19. In your present position - - - - - -						
20. Total professional experience- - - -						

Number of ☐ Semester or ☐ quarter hours of <u>College training</u> in:	0	3-6	7-12	13-18	19-24	25-50	more than 50, specify
21. Chemistry- - - - - - - - - - - - - -							
22. Physics- - - - - - - - - - - - - - -							
23. Biological science - - - - - - - - -							
24. Earth science (including geography)-							
25. Mathematics- - - - - - - - - - - - -							
26. Methods of teaching science- - - - -							

Please return to:

Glenn D. Berkheimer
Graduate Research Assistant
E-30 Holmes Hall
Science and Mathematics Teaching Center
Michigan State University
East Lansing, Michigan 48823

PERSONAL INFORMATION -- Teacher

NAME____

School System______________________________________

Street______________________________ Phone__________

City________________________________ State__________

DIRECTIONS: Please answer the following questions by checking the appropriate boxes.

1. Sex: ☐ Male ☐ Female

2. Age in years:

☐ less than 25; ☐ 25-30; ☐ 31-40;
☐ 41-50; ☐ more than 50.

3. ELEMENTARY. Indicate the percentage of the school year that you use the listed science curriculum materials in the class or classes that you currently teach.

_____% Allyn and Bacon Science Series by Thurber

_____% American Book Co. Science Series by Jacobson, Lauby and Konicek.

_____% D. C. Heath and Co. by Herman and Nina Schneider

_____% Elementary Science Study by Educational Services, Inc. (Houghton Mifflin Co.)

_____% Elementary School Science Curriculum Materials by the AAAS Commission on Science Education

_____% Elementary School Science Project Materials, University of Illinois, Co-directors: Atkin and Wyatt.

_____% Harper & Row, Publishers Science Series by Navarra and Zafforoni

_____% Macmillan Science Series by Barnard, Stendler, Spock and others

_____% Other (Please specify)________

____

100% Total

4. SECONDARY SCHOOL BIOLOGY. Indicate the percentage of your students using the listed science curriculum materials in the classes that you currently teach.

_____% BSCS Green Version: High School Biology, Rand McNally Company.

_____% Biological Science: An Inquiry Into Life (BSCS -- Yellow Version), Harcourt, Brace & World Company.

_____% Biological Science: Molecules to Man (BSCS -- Blue Version), Houghton Mifflin Company.

_____% Exploring Biology: The Science of Living Things by Ella Thea Smith

_____% Modern Biology by Moon, Otto and Towle.

_____% Other (Please specify)________

____

100% Total

5. What grade level(s) do you currently teach?

☐ K-3; ☐ 4-6; ☐ 7; ☐ 8; ☐ 9;
☐ 10; ☐ 11; ☐ 12; ☐ college

6. Indicate the approximate number of pupils attending the school in which you teach.

☐ 49 and under; ☐ 50-100; ☐ 101-200;
☐ 201-300; ☐ 301-500; ☐ 501-800
☐ 801-1200; ☐ 1201-1600; ☐ 1601 and over.

7. How many class and laboratory sessions per week do you teach science?

☐ 0- 2; ☐ 3- 4; ☐ 5- 6; ☐ 7-10;
☐ 11-15; ☐ 16-20; ☐ 21-30; ☐ 31-35.

8. Highest degree held:

☐ Bachelors; ☐ Masters; ☐ Doctorate

9. Indicate the approximate number of minutes per class session:

☐ less than 20; ☐ 21-30; ☐ 31-40;
☐ 41-50; ☐ 51-60; ☐ 61-90;
☐ 91-120; ☐ more than 121

Number of years of professional experience (count this year):	1	2	3	4-6	7-10	more than 10
10. As a teacher - - - - - - - - - - - - - - -						
11. Working with a science supervisor - - - -						
12. In your present position - - - - - - - - -						
13. Total professional experience- - - - - -						

The number of pupils you currently have in a class or laboratory session.	less than 15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	more than 50, specify
14. Maximum - - - - -									
15. Minimum - - - - -									
16. Average - - - - -									

Number of ☐ semester or ☐ quarter hours of College training in:	0	3-6	7-12	13-18	19-24	25-50	more than 50 specify
17. Chemistry- - - - - - - - - - - - - -							
18. Physics- - - - - - - - - - - - - - -							
19. Biological science - - - - - - - - -							
20. Earth science (including geography)							
21. Mathematics- - - - - - - - - - - - -							
22. Methods of teaching science- - - -							

Please return to:

Glenn D. Berkheimer
Graduate Research Assistant
E 30 Holmes Hall
Science and Mathematics Teaching Center
Michigan State University
East Lansing, Michigan 48823

APPENDIX C

MICHIGAN STATE UNIVERSITY EAST LANSING · MICHIGAN 48823

SCIENCE AND MATHEMATICS TEACHING CENTER · HOLMES HALL

November 29, 1965

Dear Science Educator:

Perhaps you have mailed your response to the QUESTIONNAIRE ON THE SCIENCE SUPERVISOR'S ROLE IN THE SELECTION AND USE OF SCIENCE CURRICULUM MATERIALS that we recently sent to you, and we may have received your response since sending this letter. If so, we want to thank you. However, if you have not completed the questionnaire as yet, we urgently request your help.

This study is extremely important to our profession because its purpose is to help determine responsibilities for science supervisors who are being employed at an ever increasing rate throughout the country. For the study to have maximum validity, all forms should be returned by science supervisors, science educators and teachers. Your cooperation in responding is vital.

In order that the forms could be completed easily and rapidly, the personal information form is so designed that you respond by checking the appropriate boxes. The questionnaire is completed by marking a response sheet. Please complete the questionnaire and return the response sheet together with the completed personal information form by December 10, 1965. A summary of the findings will be sent to those who return the completed forms with their names and addresses.

If for any reason it is impossible for you to complete the questionnaire, please state this on the response sheet and return it in the stamped envelope together with the completed first page of the personal information form by December 10, 1965. This would aid in accounting for all forms and in interpreting completed forms. If you have misplaced the questionnaire, we would be happy to send you another copy.

We know that there are many demands on your time and we hesitate to introduce an additional task to your busy schedule. However, the information sought is extremely important to our profession and only professional personnel can furnish this information.

Thank you for your cooperation.

Sincerely,

Glenn D. Berkheimer
Graduate Research Assistant

MICHIGAN STATE UNIVERSITY EAST LANSING · MICHIGAN 48823

SCIENCE AND MATHEMATICS TEACHING CENTER · HOLMES HALL

January 28, 1966

Dear Science Supervisor:

Several weeks ago we mailed to you____copies of the QUESTIONNAIRE ON THE SCIENCE SUPERVISORS' ROLE IN THE SELECTION AND USE OF SCIENCE CURRICULUM MATERIALS to be distributed to teachers under your supervision. As of January 28, 1966 we have returns from_____of these teachers.

Since the validity of findings will depend upon the percentage of completed forms returned, we request your help in making this study contribute pertinent information to our profession. Please give the enclosed follow-up letters to those teachers who have not returned their response to the questionnaire.

Any additional encouragement you can give the teachers to complete the questionnaires and return the forms promptly will be appreciated greatly.

The tentative findings of the study will be given during the National Science Supervisors Association session of the Annual Convention of the National Science Teachers Association in New York, April 1, 1966. A summary of the findings will be sent to you later in the spring.

We sincerely thank you for your contribution to our profession through this study.

Very truly yours,

Glenn D. Berkheimer
Graduate Research Assistant

css

MICHIGAN STATE UNIVERSITY EAST LANSING · MICHIGAN 48823

SCIENCE AND MATHEMATICS TEACHING CENTER · HOLMES HALL

January 28, 1966

Dear Teacher:

Perhaps you have mailed your response to the QUESTIONNAIRE ON THE SCIENCE SUPERVISORS' ROLE IN THE SELECTION AND USE OF SCIENCE CURRICULUM MATERIALS that your science supervisor gave to you, and we may have received your response since sending this letter. If so, we want to thank you. However, if you have not completed the questionnaire as yet, we urgently request your help.

This study is extremely important to our profession because its purpose is to help determine responsibilities for science supervisors who are being employed at an ever increasing rate throughout the country. For the study to have maximum validity, all forms should be returned by science supervisors, science educators and teachers. Your cooperation in responding is vital.

In order that the forms could be completed easily and rapidly, the personal information form is so designed that you respond by checking the appropriate boxes. The questionnaire is completed by marking a response sheet. Please complete the questionnaire and return the response sheet together with the completed personal information form by February 21, 1966. A summary of the findings will be sent to those who return the completed forms with their names and addresses.

If for any reason it is impossible for you to complete the questionnaire, please state this on the response sheet and return it in the stamped envelope together with the completed first page of the personal information form by February 21, 1966. This would aid in accounting for all forms and in interpreting completed forms. If you have misplaced the questionnaire, we would be happy to send you another copy.

We know that there are many demands on your time and we hesitate to introduce an additional task to your busy schedule. However, the information sought is extremely important to our profession and only professional personnel can furnish this information.

Thank you for your cooperation.

Sincerely,

Glenn D. Berkheimer
Graduate Research Assistant

June 28, 1966

Dear Teacher:

Perhaps [illegible] your response to the QUESTIONNAIRE ON THE SCIENCE SUPERVISORS' ROLE IN THE SELECTION AND USE OF SCIENCE CURRICULUM MATERIALS that your science supervisor [illegible] you [illegible] we may have received your response since sending this [illegible] we want to thank you. However, if you have not completed [illegible] questionnaire [illegible], we urgently request your help.

This study is extremely important to our profession because its purpose is to help determine responsibilities of science supervisors who are being employed at an [illegible] increasing rate throughout the country. For the study to have maximum validity, all forms should be returned by science supervisors, science [illegible] and teachers. Your cooperation in responding is vital.

In order that the forms could be completed easily and rapidly, the personal information form is so designed that you respond by checking the appropriate boxes. The questionnaire is completed by marking a response sheet. Please complete the questionnaire and return [illegible] together with the completed personal information form by [illegible] 21, 1966. A summary of the findings will be sent [illegible] completed forms with their names and addresses.

If for any reason [illegible] questionnaire, please state this [illegible] return it in the stamped envelope together with the completed [illegible] personal information form by [illegible] 21, 1966. This [illegible] accounting for all forms and in interpreting [illegible]. If [illegible] misplaced the questionnaire, we would be happy to send you another copy.

[illegible] there are many demands on your time and we hesitate to introduce an additional [illegible] your busy schedule. However, the information sought is extremely important to our profession and only professional personnel can furnish this information.

Thank you for your [illegible].

Sincerely,

[illegible] Smith [illegible]
[illegible] Research Assistant

APPENDIX D

CHI SQUARE VALUES CALCULATED FROM RESPONSES OF SCIENCE SUPERVISORS AND TEACHERS USING NSF SPONSORED SCIENCE PROJECT MATERIALS AND THOSE USING COMMERCIAL SCIENCE CURRICULUM MATERIALS

N = 557; DEGREES OF FREEDOM = 4

Ho_1: $CM_1 = CM_2$ Characteristics of Science Curriculum Materials		Ho_2: $Obj_1 = Obj_2$ The Objectives of Science Education	
2.[a]	21.013***	1.	11.589*
4.	6.341	3.	11.118*
5.	19.056***	6.	23.043***
8.	4.446	7.	3.996
10.	11.374*	9.	25.772***
11.	32.407***	12.	2.802
13.	7.665	14.	5.747
16.	13.829**	15.	15.001**
17.	6.321	18.	28.471***

[a]These numbers correspond to those on the questionnaire presented in Appendix B.

*Significant at the .05 level.

**Significant at the .01 level.

***Significant at the .001 level.

APPENDIX E

CHI SQUARE VALUES: A COMPARISON OF ELEMENTARY SCHOOL SCIENCE SUPERVISORS AND TEACHERS USING NSF SPONSORED SCIENCE PROJECT MATERIALS WITH THOSE USING COMMERCIAL SCIENCE CURRICULUM MATERIALS
N = 280; DEGREES OF FREEDOM = 4

Curriculum			Leadership		
Actual Behavior		Recommended Behavior	Actual Behavior		Recommended Behavior
27.[a]	4.828	6.668	19.	5.836	3.188
29.	20.889***	11.851*	20.	1.994	2.509
34.	32.216***	32.903***	21.	2.503	2.464
37.	13.529**	17.400**	22.	1.423	4.183
40.	5.174	6.123	26.	2.336	3.487
41.	1.178	1.889	28.	11.889*	8.830
42.	2.577	1.151	47.	12.496*	8.822
43.	1.929	0.380	48.	2.986	4.668
44.	1.349	3.890	49.	5.951	2.381
45.	3.349	3.030	57.	11.798*	4.216
46.	9.447	6.442	58.	7.825	1.397
50.	7.881	5.485	59.	8.268	7.108
67.	3.137	1.422	61.	1.422	5.205
69.	8.748	1.392	71.	7.269	2.455
70.	4.682	3.117	72.	2.079	1.156
74.	2.351	1.035	73.	11.729*	2.606
76.	3.507	2.507	75.	10.674*	5.595
77.	10.796*	7.106			

[a]These numbers correspond to those on the questionnaire presented in Appendix B.

*Significant at the .05 level.

**Significant at the .01 level.

***Significant at the .001 level.

APPENDIX E--Continued

In-Service			Equipment-Materials		
	Actual Behavior	Recommended Behavior		Actual Behavior	Recommended Behavior
23.	6.080	3.539	30.	5.276	0.353
24.	7.095	1.371	31.	7.003	4.212
25.	2.693	0.858	32.	4.319	2.977
51.	1.847	3.437	33.	10.396*	3.053
52.	8.610	2.255	35.	9.711*	8.662
53.	0.661	0.872	36.	9.479	17.379**
54.	2.124	7.457	38.	3.789	5.247
55.	4.004	4.921	39.	6.151	5.334
56.	3.297	2.871	65.	1.596	3.765
60.	4.061	1.174	78.	3.378	0.105
62.	3.851	1.126	79.	7.899	5.995
63.	5.490	4.851	80.	19.227***	6.678
64.	6.289	6.595	81.	6.881	11.372*
66.	19.578***	2.710	82.	2.509	1.844
68.	3.397	1.890			

*Significant at the .05 level.

**Significant at the .01 level.

***Significant at the .001 level.

APPENDIX F

CHI SQUARE VALUES: A COMPARISON OF SECONDARY SCHOOL SCIENCE SUPERVISORS AND BIOLOGY TEACHERS USING NSF SPONSORED SCIENCE PROJECT MATERIALS WITH THOSE USING COMMERCIAL SCIENCE CURRICULUM MATERIALS
N = 372; DEGREES OF FREEDOM = 4

Curriculum			Leadership		
	Actual Behavior	Recommended Behavior		Actual Behavior	Recommended Behavior
27.[a]	6.285	2.381	19.	7.338	3.697
29.	23.889***	10.209*	20.	0.620	1.815
34.	11.328*	18.538***	21.	2.961	3.297
37.	15.695**	5.862	22.	9.924*	5.520
40.	1.360	4.029	26.	0.865	1.540
41.	11.394*	10.249*	28.	21.779***	8.190
42.	3.424	2.507	47.	2.662	8.048
43.	9.612*	7.449	48.	12.269*	9.388
44.	9.222	12.013*	49.	6.114	0.569
45.	11.031*	9.369	57.	22.579***	6.654
46.	4.427	4.860	58.	13.855**	3.401
50.	9.673*	8.558	59.	13.893**	7.731
67.	15.803**	9.608*	61.	3.110	5.106
69.	4.278	3.088	71.	6.837	3.411
70.	0.841	3.365	72.	6.392	3.036
74.	6.465	3.986	73.	11.382*	0.878
76.	7.926	2.315	75.	12.053*	11.627*
77.	7.916	4.424			

[a]These numbers correspond to those on the questionnaire presented in Appendix B.

*Significant at the .05 level.

**Significant at the .01 level.

***Significant at the .001 level.

APPENDIX F--Continued

In-Service			Equipment-Materials		
	Actual Behavior	Recommended Behavior		Actual Behavior	Recommended Behavior
23.	6.142	2.322	30.	1.691	0.400
24.	1.847	1.183	31.	4.271	4.904
25.	2.997	5.409	32.	1.361	2.946
51.	12.219*	4.771	33.	6.578	0.816
52.	1.408	2.175	35.	4.703	2.462
53.	5.260	3.344	36.	7.897	9.199
54.	12.503*	10.724*	38.	4.457	13.703**
55.	5.547	2.124	39.	7.505	11.291*
56.	15.477**	6.217	65.	1.703	1.250
60.	2.763	2.070	78.	3.316	10.364*
62.	7.544	4.306	79.	4.186	10.664*
63.	5.128	3.376	80.	7.223	3.459
64.	1.832	2.656	81.	1.815	5.842
66.	2.979	1.119	82.	4.606	2.474
68.	5.800	6.107			

*Significant at the .05 level.

**Significant at the .01 level.

***Significant at the .001 level.

APPENDIX G

CHI SQUARE VALUES: A COMPARISON OF THE ACTUAL SCIENCE SUPERVISOR BEHAVIORS AS PERCEIVED BY ELEMENTARY SCHOOL SCIENCE SUPERVISORS AND TEACHERS WITH THOSE PERCEIVED BY SECONDARY SCHOOL SCIENCE SUPERVISORS AND BIOLOGY TEACHERS
N = 462; DEGREES OF FREEDOM = 4

Curriculum			Leadership		
Actual Behavior		Recommended Behavior	Actual Behavior		Recommended Behavior
27.[a]	27.055***	13.051*	19.	10.442*	8.806
29.	6.234	2.937	20.	1.248	2.807
34.	4.973	9.650*	21.	10.450*	4.844
37.	6.156	1.867	22.	10.279*	3.126
40.	21.742***	2.435	26.	3.130	2.686
41.	43.991***	13.780**	28.	15.856**	8.390
42.	23.103***	21.732***	47.	18.001**	2.037
43.	24.756***	6.071	48.	16.913**	9.122
44.	15.095**	1.683	49.	26.184***	6.452
45.	13.833**	0.975	57.	7.371	0.834
46.	10.589*	4.991	58.	11.529*	3.683
50.	6.886	3.951	59.	29.208**	15.745**
67.	5.894	6.690	61.	49.821***	41.271***
69.	20.259***	7.260	71.	12.983*	3.523
70.	11.326*	10.463*	72.	5.754	6.244
74.	17.896**	4.877	73.	14.427**	2.138
76.	8.189	3.557	75.	30.785***	20.516***
77.	14.602**	5.943			

[a]These numbers correspond to those on the questionnaire presented in Appendix B.

*Significant at the .05 level.

**Significant at the .01 level.

***Significant at the .001 level.

APPENDIX G--Continued

In-Service			Equipment-Materials		
	Actual Behavior	Recommended Behavior		Actual Behavior	Recommended Behavior
23.	81.369***	46.168***	30.	21.680***	14.573*
24.	8.297	2.893	31.	24.560***	3.956
25.	36.516***	6.650	32.	1.059	5.307
51.	31.345***	22.452***	33.	24.267***	14.498**
52.	7.855	11.153*	35.	13.057*	11.270*
53.	43.483***	29.188***	36.	14.157**	22.755***
54.	20.325***	11.573*	38.	19.422***	3.195
55.	34.397***	17.597**	39.	4.465	2.329
56.	5.518	7.562	65.	46.102***	25.707***
60.	13.256*	4.763	78.	20.958***	8.780
62.	8.612	5.420	79.	35.115***	14.338**
63.	14.610**	14.690**	80.	10.054*	3.342
64.	33.774***	21.055***	81.	12.911*	7.579
66.	16.140**	10.381*	82.	18.837***	6.550
68.	10.690*	6.407			

*Significant at the .05 level.

**Significant at the .01 level.

***Significant at the .001 level.

APPENDIX H

CHI SQUARE VALUES: A COMPARISON OF RECOMMENDED SCIENCE SUPERVISORY BEHAVIORS BY COLLEGE SCIENCE EDUCATORS WITH THOSE OF SCIENCE SUPERVISORS
N = 464; DEGREES OF FREEDOM = 4

Curriculum		Leadership		In-Service		Equipment Materials	
27.[a]	3.922	19.	14.139**	23.	3.618	30.	11.709*
29.	1.876	20.	3.127	24.	9.656*	31.	1.138
34.	0.821	21.	9.296	25.	14.993**	32.	20.136***
37.	6.504	22.	8.117	51.	5.679	33.	2.995
40.	6.573	26.	26.465***	52.	6.342	35.	3.645
41.	7.311	28.	7.832	53.	2.923	36.	15.544**
42.	3.860	47.	10.815*	54.	2.687	38.	12.401*
43.	2.463	48.	22.468***	55.	8.092	37.	28.495***
44.	0.264	49.	2.625	56.	9.408	65.	1.807
45.	1.571	57.	5.463	60.	13.851**	78.	9.707*
46.	11.064*	58.	25.874***	62.	0.594	79.	6.669
50.	2.238	59.	10.157*	63.	2.726	80.	33.204***
67.	6.302	61.	13.179*	64.	1.576	81.	8.937
69.	3.706	71.	0.442	66.	5.444	82.	24.980***
70.	5.616	72.	2.397	68.	4.924		
74.	5.217	73.	11.441*				
76.	1.497	75.	0.856				
77.	11.210*						

[a]These numbers correspond to those on the questionnaire presented in Appendix B.

*Significant at the .05 level.

**Significant at the .01 level.

***Significant at the .001 level.

APPENDIX I

CHI SQUARE VALUES: A COMPARISON OF RECOMMENDED SCIENCE SUPERVISORY BEHAVIORS BY COLLEGE SCIENCE EDUCATORS WITH THOSE OF ELEMENTARY AND SECONDARY SCHOOL TEACHERS
N = 529; DEGREES OF FREEDOM = 4

Curriculum	Leadership	In-Service	Equipment-Materials
27.[a] 1.904	19. 5.856	23. 8.603	30. 12.558*
29. 11.070*	20. 4.087	24. 50.268***	31. 4.281
34. 13.432**	21. 4.900	25. 5.119	32. 38.784***
37. 13.906**	22. 9.645*	51. 8.529	33. 23.270***
40. 7.425	26. 17.922**	52. 9.758*	35. 11.346*
41. 3.533	28. 6.335	53. 4.940	36. 50.186***
42. 3.972	47. 7.281	54. 18.923***	38. 7.879
43. 6.814	48. 7.135	55. 2.581	39. 19.469***
44. 6.631	49. 14.973**	56. 23.419***	65. 7.735
45. 3.272	57. 3.801	60. 20.220***	78. 2.501
46. 3.733	58. 40.226***	62. 12.328*	79. 4.941
50. 6.380	59. 17.495**	63. 9.784*	80. 15.639**
67. 18.321**	61. 26.947***	64. 10.080*	81. 11.924*
69. 9.120	71. 8.596	66. 24.976***	82. 47.656***
70. 6.765	72. 5.604	68. 13.028*	
74. 9.739*	73. 4.368		
76. 32.975***	75. 7.302		
77. 4.591			

[a]These numbers correspond to those on the questionnaire presented in Appendix B.

*Significant at the .05 level.

**Significant at the .01 level.

***Significant at the .001 level.