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AN ANALYSIS OF THE OPINIONS OF ELEMENTARY SCIENCE

BY TWO GROUPS OF TEACHERS

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CHAPTER I

THE PROBLEM

There has been some kind of science program in schools since Franklin opened his famous academy. With the present emphasis on the instruction of science in the elementary school, however, many questions have been raised relative to the effectiveness of the present program in Oklahoma.

As the discipline of science is increasingly introduced into the elementary curriculum there has been criticism voiced. Much of this criticism has been based on the idea that elementary school children have not yet attained that stage of intellectual development conducive to the study of science.

A review of the literature demonstrates that the intellectual development of elementary pupils is such that the pursuit of elementary science concepts is possible. Karplus describes this relationship between science and young children this way:

> The older view of the development of children held that the early grades were, in part, a period of waiting for maturity. Today we recognize that intellectual stimulation during the formative years is as important as native endowment in determining the future achievement of each child. Such a modern view permits the elementary school to make a greater, more vital contribution than ever before.[1]

Bruner, speaking in a manner similar to Karplus, has indicated that children should be challenged to learn ways of thinking early:

> There is nothing more central to a discipline than its way of thinking. There is nothing more important in its teaching than to provide the child the earliest opportunity to learn that way of thinking--the forms of connection, the attitudes, hopes, jokes, and frustrations that go with it . . . At the very first breath, the young learner should, we think, be given the chance to solve problems, to conjecture, to quarrel, as these are done at the heart of the discipline.[2]

Karplus and Bruner, therefore, are stating that not only can the discipline be used with young children, but it should be used early in the educational experience of children. Both Karplus and Bruner refer to outcomes from the teaching of science such as ". . . intellectual stimulation . . ." and ". . . ways of thinking . . ." In other words, these two scholars are inferring that science properly taught in the elementary school can make a contribution to the development of a child's thinking ability.

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[1]Robert Karplus, "A New Look at Elementary School Science," The Instructor, Vol. LXXIV, (January, 1965), pp. 45-47.

[2]Jerome S. Bruner, Toward a Theory of Instruction, (Cambridge, Massachusetts: Harvard University Press, 1966), p. 155.

To examine whether or not that statement is true, the phrase "thinking ability" must be defined. The Educational Policies Commission has defined the rational powers of recalling, imagining, classifying, generalizing, comparing, evaluating, analyzing, synthesizing, deducing, and inferring as ". . . the essence of the ability to think."[3] If one closely inspects the ten rational powers listed above, he immediately sees that they represent the thinking acts which Bruner was referring to when he stated that young learners must be given the chance to develop the ability to solve problems, quarrel, conjecture, hope and be frustrated by the discipline itself. Quarreling, conjecturing, and developing attitudes complementary to the discipline of science are not possible unless you evaluate, compare, imagine, analyze, synthesize, and use all the rational powers. Science in the elementary school must be there for the reasons cited by Karplus and Bruner because experience in the discipline provides an excellent opportunity for the development of the rational powers of the child.

Aylesworth concluded that we cannot ignore science in the elementary classroom because:

> . . . part of the function of the school is to assist the child in the interpretation of his environment . . .[4]

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[3]Educational Policies Commission, The Central Purpose of American Education, (Washington, D.C.: National Education Association, 1961), p. 12.

[4]Thomas G. Aylesworth, "Elementary School Science," Education, Vol. 82, (October, 1961), pp. 83-86.

Here then, is a second major purpose for teaching science in the elementary classroom; i.e., while developing his rational powers, a child can have curricula experiences which will allow him to develop an understanding of his environment.

In addition to the two major purposes of teaching science in the elementary school, Bloom states that elementary school science has the following unique opportunities and responsibilities:

(1) to deepen understanding and appreciation of the environmental factors and their control

(2) to increase the knowledge and the ability to apply scientific principles

(3) to improve continually the ability to use the methods of science in attacking everyday problems

(4) to increase the understanding of the impact of science upon the individual and society.[5]

In summary science should be included in the elementary school curriculum since it provides, among other things, a way by which the intellectual development of the child can be furthered.

The major criticism of most elementary school science presently found were succinctly summarized by Renner and Ragan when they said:

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[5]Samuel W. Bloom, "How Effective is Science in the Elementary School?" School Science and Mathematics, Vol. 59, (February, 1959), pp. 94-98.

> Science teaching in the elementary school has frequently been ineffective because (1) it emphasized the learning of facts as ends in themselves, (2) it placed too much emphasis on the products of science and not enough on the processes, and (3) it did not provide sufficient opportunities for pupils to engage in investigative activities.[6]

Criticism, as exemplified by the foregoing quotation, cannot be ignored and in order to test the validity of such criticism, an examination of the types of programs now in use should be made. The examination needs to include looking at such observable factors as teaching procedures, content, materials used and the time devoted to the study of science. Establishing, for example, a value for the latter factor, i.e., time devoted to science, can provide real insight into the importance which a teacher attaches to science in the elementary school curriculum. There is probably a relationship between the degree of importance a teacher attaches to the subject and how well children are led to achieve its objectives. Perhaps the procedures used in teaching elementary school science are not those that are best suited to accomplish the desired objectives. Probably and even of greater importance, is the fact that elementary teachers may not be aware of the objectives to be achieved through science.

The type of content used in elementary school science will reveal whether or not teachers view science as a

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[6]John W. Renner and William B. Ragan, Teaching Science in the Elementary School, (New York: Harper and Row, 1968), p. 35.

vehicle to lead a child to develop his rational powers and/or if teachers view rational power development as an educational responsibility. In other words, examining certain observable factors related to the teaching of elementary school science could lead to an understanding of why teachers believe science is in the elementary school. Such an examination can also allow an evaluation to be made of the criticisms of this area of the elementary school curriculum. In addition, an examination of the way groups of teachers who have been educated in different ways, value the same observable factors related to elementary school science, can provide information relative as to how teachers should be educated if they are to teach in a manner which will lead children to achieve the previously stated purposes of the subject.

Statement of Problem

The specific problem of this study is to determine if teachers who have had education in inquiry-centered science education hold opinions about the teaching procedures, materials, content, and time for elementary school science which are different from those opinions held by teachers whose science program is centered around the textbook. In this study the former group will be referred to as inquiry centered and the latter groups as textbook centered.

A Comparison of Textbook-Centered and Inquiry-Centered Teachers

Many elementary science teachers rely solely on a textbook, or a series of textbooks, for their science program. Many of these textbooks present a cut and dried procedure to the children; i.e., they give directions on what steps to follow, what the results will be, and the conclusions to be reached. In a procedure of this nature the pupil is not challenged to perform any individual thinking on his own. Karplus has indicated that the foregoing is the greatest weakness of the current practice. He describes the consequences of this procedure as follows:

> . . . an almost exclusive reliance on textbooks and other such authoritative sources of information. These sources for science learning, however, are quite impotent compared to the direct experiences that nourish the pupil's intellectual development of "common sense" rationality. Instead of guiding this development in the direction of modern scientific understanding, therefore, the present-day science courses create a second, separate, relatively abstract structure which is not used outside the school situation and which eventually atrophies.[7]

Moorehead, after an analysis of elementary science textbooks, reports that:

> The majority of the experiments in these books is of the "cookbook" type, and it is only natural for teachers to develop content-centered objectives. . . . They say process, but are teaching content.[8]

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[7]Robert Karplus, "The Science Curriculum Improvement Study," Journal of Research in Science Teaching, Vol. 2:4, 1964, pp. 293-303.

[8]William Douglas Moorehead, "The Status of Elementary School Science and How It Is Taught," (Unpublished Ph.D., dissertation, Oklahoma University, 1965), p. 99.

Scott found that in those elementary classrooms where provision is made for science instruction:

> . . . almost without exception the program is prescribed by the children's science textbooks. Most of the science textbooks for young children offer some structure for the science program.[9]

Such structure, the investigator believes is not of the type that would lead to the development of the elementary school science objectives that have been stated in this study. Scott feels that the elementary school science program should focus upon involvement of the learner. It should:

> . . . condition the learner to seek the answer for himself, which would promote reasoned guessing and the subjection of guesses to controlled tests, would foster inductive logic and discovery.[10]

The investigator agrees with Scott and others but he also believes that most elementary teachers are reluctant to allow the pupils to proceed with a curriculum which would permit them to perform science investigations on their own. They stifle individual thinking by forcing the pupils to always arrive at a simple proven answer and, in so doing, force the pupils to think as adults. Karplus believes that many teachers are reluctant to let pupils draw their own learning from an experience. He describes how such teachers view their responsibility in this way:

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[9]Lloyd Scott, "An Experiment in Teaching Basic Science in the Elementary School," Science Education, Vol. 46:2, (March, 1962), p. 108.

[10]Ibid.

> They feel they should summarize at the end of the period what has happened and what they intended the children to learn. This tendency among teachers is so common that it has been given a name, lysiphobia--the fear of leaving "loose ends." Tying things up in a neat package cuts off the gradual growth in understanding which comes when children try out their glimmerings of new ideas on their experiences at school and at home.[11]

Taba pointed out the value of a curriculum which encourages learning by inquiry (or discovery) when she stated:

> Discovery learning is characterized by active experiencing of inquiry: by structuring the very method of attacking problems, by looking for regularities and reasonable patterns, by using experience in the search. To develop this approach to learning, students should be helped to experience rational processes rather than be allowed to arrive at the right answers by whatever processes they choose.[12]

Kersh speaking in a manner similar to Taba reports:

> The discovery method is effective for what it requires the learner to do and for what is reinforced during learning. The learner may acquire more effective ways of problem solving through the discovery process than through another process simply because he has an opportunity to practice different techniques and because his more effective techniques are reinforced.[13]

An article written by a diverse group of Oklahoma educators dedicated to the encouragement of inquiry teaching points out:

> Inquiry does not always result in a solution to the problem. But inquiry seldom, if ever, proves

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[11]Karplus, "New Look at Elementary School Science," pp. 45-47.

[12]Hilda Taba, Curriculum Development and Practice, (New York: Harcourt, Brace and World, Inc., 1962), p. 155.

[13]Bert Y. Kersh, "Learning by Discovery: What is Learned?" The Arithmetic Teacher, April, 1964, p. 230.

> fruitless in the sense that one would have been better off had he not inquired. In fact, the really lasting educational benefit of the inquiry is the search itself since it is during this search that the thinking ability of the investigator is being developed.[14]

Summary

Textbooks are impotent when compared to direct experiences that nourish the pupils' intellectual development of "common sense" rationality. Textbooks develop content-centered teachers and fail to involve the learner or fire the children's imagination. The teachers cut off the gradual growth of understanding by explaining what has happened and what was supposed to be learned.

Curricula which encourage learning by inquiry aid children to experience rational processes; they acquire more effective ways of problem solving. The educational benefit of the inquiry process is to develop the thinking ability of the investigator.

New Curriculum Developments

Relative to the status of the elementary school curriculum Atkin concluded:

> The elementary school science curriculum in most American schools is based on a pioneering study reported by Craig in 1927. The results of this study have served us well for over thirty years. But the inevitable questions must now be asked: Is the curriculum appropriate today? Are basic revisions necessary? Is it satisfactory to retain the essential structures of

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[14] "Inquiry," Oklahoma Teacher, November, 1968, p. 17.

> this curriculum and make only those minor modifications demanded by new science knowledge.[15]

Many educators have been concerned about the ineffectiveness of the elementary school science curricula and have brought about a concerted effort in order to initiate improvements in the program. Professors of education and science education have been joined by scientists, elementary school teachers, sociologists, and psychologists in working out various types of programs which they believe will improve elementary school science. If one believes that the primary task of teachers of elementary school science is that of encouraging creative thinking, some of the newer procedures may prove to be more adaptable than present textbook-centered programs are to this purpose. Duckworth explains the characteristics of the materials in such programs like this:

> They must be inexpensive so that each child in a class, or at least each pair of children, can work individually. They must be simple enough so their functioning is clear, and children can raise their own questions about the materials and use them to find their own answers. They must be rich enough in possibilities so that initial questions can lead to problems of greater demand and significance.[16]

One of the new inquiry-centered programs, the Elementary Science Study (ESS) has as its objective the development of

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[15]Myron J. Atkin, "The Elementary School Science Curriculum," Science Teacher, Vol. 27, (March, 1960), pp. 51-54.

[16]Eleanor Duckworth, "The Elementary Science Study Branch of Educational Services Incorporated," Journal of Research in Science Teaching, Vol. 2:3, 1964, pp. 241-243.

meaningful science materials for elementary school science. These materials are designed from the ideas originating from the curiosity of children. According to Duckworth the ESS program can be characterized in this manner:

> There are two main characteristics which are kept in mind: (1) the children use materials themselves, individually or in small groups, often raising the questions themselves, answering them in their own way, using the materials in ways the teacher had not anticipated, and coming to their own conclusions, and (2) we try to create situations where children are called upon to talk to each other.[17]

Science--A Process Approach is the elementary science program of the American Association for the Advancement of Science; it is designed to improve the child's skills in using the processes of science. Gagné reports that the most striking characteristic of the Process Approach is:

> To teach children the processes of science rather than what may be called content. That is, they are directed toward developing fundamental skills required in scientific activities. The performance in which these skills are applied involve objects and events of the natural world; the children do, therefore, acquire information from various sciences are they proceed. The goal, however, is not an accumulation of knowledge about any particular domain, such as physics, biology, or chemistry, but competence in the use of processes that are basic to all sciences.[18]

The Science Curriculum Improvement Study (SCIS) is concerned with exploring a concept of science education based on communicating scientific literacy. According to

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[17] Ibid.

[18] Robert M. Gagné, "Elementary Science: A New Scheme of Instruction," Science, Vol. 151, (January, 1966), pp. 49-53.

Karplus the curriculum plan of the Science Curriculum Improvement Study is:

> To acquaint pupils with specific examples of objects and organisms, to let them investigate definite examples of natural phenomena, and to help them develop skills manipulating equipment and recording data. The program is characterized by two features in order to satisfy the long range objectives. First, there is extensive direct contact of the children with natural phenomena. As much information as possible is gathered by the children through their own observations. Little is told them by the teachers or their books. Second, there is a slow accumulation of abstractions in a hierarchy, with broad concepts being introduced early and more sophisticated distinctions being made later.[19]

Renner and Ragen discovered that the new curriculum developments have some common elements. These common elements are:

(1) They emphasize the necessity of children's doing experiments; i.e., the integrity of the discipline of science is maintained

(2) to encourage the learner to develop his rational powers which are the essence of the ability to think

(3) to develop the child's conceptual structure of science

(4) to broaden the child's understanding of his environment

(5) children are not required to memorize factual information

(6) designed to affect a true behavioral change in children, and

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[19]Robert Karplus, "The Science Curriculum Improvement Study," Journal of School Science and Mathematics, Vol. 2:4, 1964, pp. 293-303.

(7) to provide children the opportunity to have the five essential learning experiences: observation, measurement, experimentation, data interpretation, and prediction.[20]

Review of Related Research

The investigator found the research which was related to this problem very limited. This finding is possibly due to the newness of the inquiry approach to teaching elementary school science. There were, however, several studies which at least tangentially related to this study. The first three studies which are reviewed are related to learner achievement through inquiry and the last is directly related to teaching performance of inquiry-centered versus textbook-centered teachers.

Suchman reports these conclusions about inquiry training after an analysis of three pilot studies:

> Most of the children who received training became more productive in their design and use of verification and experimentation. They developed a fairly consistent strategy which they can transfer to new problem situations. They make fewer untested assumptions; they formulate and test more hypotheses; and they perform more controlled vs. uncontrolled experiments in the course of their inquiry.[21]

Scott reported a study supported by the Cooperative Research Program of the United States Office of Education titled, "Effects of Inquiry Training in Physical Science on

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[20]Renner and Ragan, "Teaching Science Elementary School," p. 307.

[21]Richard J. Suchman, "Inquiry Training in the Elementary School," Science Teacher, Vol. 27:7, (November, 1960), pp. 42-47.

Creativity and Cognitive Styles of Elementary School Children," which supports the inquiry process as follows:

> Three hundred Detroit, Michigan public school children in grades four, five, and six were taught a series of fifteen science concepts, five at each grade level. Half of the children were taught using the Detroit Inquiry process and the other half were taught by conventional methods, with the following conclusions and implications:
>
> (1) the Inquiry process seems to provide a climate for development of needed mental and verbal skills among the boys and at the same time, continues to stimulate the girls in their problem-solving activities
>
> (2) . . . the conceptual processes of the Inquiry children were significantly different from those conventionally taught students . . . stylistic preferences of the Inquiry children could be definitely related to specific aspects of the problem-solving strategy used in the science lessons
>
> (3) the Inquiry process encourages an exploratory attitude on the part of the child, and the searching process is his own, resulting in questions generated within his own cognitive structure, and
>
> (4) the Inquiry strategy encourages an analytical mode on the part of the child that leads him beyond the overt perceptual phenomena inherent in our physical world.[22]

Thier completed a study on first grader's understanding of matter:

> Thirty first graders at the trial school and thirty first graders in the same community who had not participated in the program were interviewed. Three experiments were performed. The term "test group" was used to denote those children who studied the unit Material Objects. The term "control group" was used to refer to the children who did not study the unit.

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[22]Norval C. Scott, Jr., "The Strategy of Inquiry and Styles of Categorization," Journal of Research in Science Teaching, Vol. 4:1, 1966, pp. 143-153.

> The difference in results found for the test and control group children indicates that the test group children are superior in their ability to describe objects by their properties.[23]

These three research studies show that children who are taught by Inquiry make greater progress toward the purposes of elementary school science which were stated earlier in this chapter than do children who have textbook-centered experience in this curriculum area.

But in order to learn by inquiry, teachers must teach that way. If one considers the type of experiences prospective teachers have in college, the fact that most of those experiences are the antithesis of inquiry is obvious. Can teachers, therefore, be educated to teach by the inquiry method? Wilson analyzed the teaching patterns of two groups of teachers at the elementary school level. He defined the problem this way:

> The purpose of this study was to investigate and analyze the teaching procedures of two groups of science teachers at the elementary school level. . . . to determine whether the teachers who had been instructed in the SCIS program were encouraging their pupils to indulge in a significantly larger number of the "essential science experiences" than those teachers who had not had instruction in any "new" science program.

The "essential science experiences" have been identified earlier in this chapter by Renner and Ragan. Wilson's procedure consisted of:

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[23]Herbert D. Thier, "A Look at a First Grader's Understanding of Matter," Journal of Research in Science Teaching, Vol. 3:1, 1965, pp. 84-89.

> Two instruments were used for the collection and recording of data taken from the observations. One of the instruments was designed for categorization of different science experiences encouraged by the teacher. The second instrument was designed for categorization of different types of questions by the teacher.[24]

Wilson reached the following conclusions:

> (1) There was a significant difference in essential science experiences between the two groups of teachers (Wilson designates these science experiences as: observation, measurement, experimentation, data interpretation, and prediction).
>
> (2) There was a significant difference in the questions representing the lowest level of thinking and those questions representing the highest level of thinking between the two groups of teachers.
>
> (3) The SCIS-educated teachers encouraged pupils to become involved in over twice as many essential science experiences as did the traditional science teachers.
>
> (4) The teachers using the inquiry-discovery approach apparently are encouraging the use of the learner's higher cognitive powers because of the nature of the questions asked in the classroom.
>
> (5) The SCIS-educated teachers used significantly more demonstrations of skill-type questions. This suggests that these teachers are probably treating science more like a skill subject than a content subject.
>
> (6) Not only are the SCIS-educated teachers asking more questions of the higher cognitive type, but they are asking more questions in general.[25]

Wilson's study reveals that teachers using the "new" approaches to teaching elementary school science seem to provide elementary pupils with these advantages:

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[24]John H. Wilson, "Differences Between the Inquiry-Discovery and the Traditional Approaches in Teaching Science in Elementary Schools," (Unpublished Ed.D. dissertation, Oklahoma University, 1967), pp. 8-11.

[25]Wilson, "Differences Between the Inquiry-Discovery and the Traditional Approaches Teaching Science in Elementary," pp. 67-69.

1. They become more productive in essential science experiences.

2. They are encouraged to use their higher cognitive powers.

3. Pupils are introduced to science as a skill subject rather than a content subject.

The investigator believes that the above points are of value in fulfilling the goals of elementary school science which have been previously stated in this chapter.

Need for Study

A study of the elementary school science program in Oklahoma was needed to determine if those teachers who had received instruction in the inquiry method of teaching held opinions regarding procedures for elementary school science that varied from those teachers who were educated to teach from a textbook. This information will also demonstrate how the teachers in the elementary schools of Oklahoma view the state guidelines for elementary school science. The guide for The Improvement of Science Instruction in Oklahoma Grades K-6 makes the following recommendations as set out by the State Department of Education:

1. To teach and evaluate for an understanding of how the principles of science are developed, of how concepts are formed, and how they undergo change

2. To provide those experiences for students which will "focus" their attention on thinking (problem solving experiences)

3. To provide the child with experiences which contribute to his "sheer joy of knowing"

4. To develop within the child the ability to learn science for himself; this can best be done through the discovery method

5. To provide children with the opportunity to study science in an atmosphere which is conducive to solving problems

6. To develop habits of careful observation

7. To help students learn to identify relevant information, master the techniques of critical analysis, and make independent judgments.

When teaching is directed toward observation, communication, measurement, inference and conclusion, the result will be a behavioral change in the child.[26]

These guidelines give an unqualified endorsement to the inquiry approach. Only when such information is available will those responsible for the curriculum, at the state and local levels, be able to undertake steps to bring the elementary school science curriculum into harmony with the latest research on that subject. Such information is, also, of value to teacher education institutions; it provides them with a picture of how far their efforts in modernizing their subject area have gone. Only when those institutions have that information can they design and alter programs to assist them in discharging their curricula responsibilities to the schools.

Procedure

The problem was attacked by conducting a survey that would allow teachers to express opinions of the kinds

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[26]"The Improvement of Science Instruction in Oklahoma--Grades K-6," Oklahoma State Department of Education, Oklahoma City, August, 1968, p. 2.

and degrees of satisfaction and dissatisfaction they encountered in the teaching of elementary school science. The mail survey was selected since the respondents were all in-service teachers widely distributed in selected areas of Oklahoma. In order to obtain a maximum return of the questionnaire, a follow-up letter was sent to the non-respondents after a lapse of two weeks.

A trial edition of the questionnaire based on the literature findings was mailed to sample populations, similar to the ones investigated. The purpose of the trial edition of the questionnaire was to test the questions, code them properly, and to determine the reactions of teachers to the questions. By a critical analysis of the trial questionnaires, the investigator developed an improved final form of the questionnaire. A self-addressed stamped envelope was enclosed for those returning the questionnaire.

A list of teachers concentrated in the areas of three of the State's four year colleges: (1) Northeastern State College at Tahlequah, (2) Northwestern State College at Alva, and (3) Southeastern State College at Durant was selected from the Certification Office of the State Department of Education of Oklahoma. A random sample of 280 teachers was selected from that group and represents the textbook-centered sample for this study. Any persons drawn for the sample who were using the recent curriculum developments in elementary science were discarded and another draw

was made. A second group of 70 elementary teachers selected by the Director of the Science Curriculum Improvement Study of the University of Oklahoma who had had education in the inquiry method of teaching, was also sent the questionnaire.

The opinions of the two groups of teachers regarding the following points was investigated:

1. Their evaluation of classroom management of science programs,
2. their evaluations of opportunities to improve the science program,
3. their evaluations of classroom aids,
4. their evaluation of physical and library facilities,
5. their procedures for selecting science content, and
6. classroom time spent in subject areas at each grade level.

Limitations of the Study

This study was undertaken as a two-phase procedure. Phase I was limited to teachers of the traditional program now used by the majority of the elementary teachers in Oklahoma. Phase II was limited to Oklahoma teachers who offer an inquiry-centered program.

Phase I of the study was confined to responses to a questionnaire distributed to three college areas of Oklahoma. There is, however, no reason to believe that representatives of these three areas are different than those of the entire State of Oklahoma. These areas consisted of teachers who

had not had education in the inquiry method and whose program is centered around a textbook.

Phase II of the study was confined to responses to a questionnaire distributed to teachers in the proximity of the University of Oklahoma who had been educated in the inquiry method of teaching. At the time of the study, this was the only established center for educating teachers in the inquiry method of teaching.

Data Interpretation

Measurements were tabulated as follows:

1. The two phases of the study were related by the use of tables and/or graphs of the six investigative points.

2. Where statistical tests were called for, the t-test was used.

3. The statistical technique appropriate to the data collected in this research allows the null hypothesis to be tested. Each time the statistical technique was employed, the hypothesis that the textbook-centered group held opinions which were no different from the inquiry-centered group was tested.

In evaluating statistical hypotheses, two types of error are possible. Type I is rejecting a true hypothesis and Type II error is the acceptance of a false hypothesis. The type of error an investigator is most willing to risk is determined by the consequences of making either type of

error. Suppose a Type I error was made in this study. A Type I error in this research would mean accepting the notion that the two groups of teachers were not alike when in fact they were. If the two groups of teachers were exactly alike with respect to the criteria being considered, each procedure (i.e., the inquiry-centered and the textbook-centered) is as effective as the other. There is no need to do anything. But, if we falsely accept that one procedure is better than the other, money, time, and energy will be spent needlessly in adjusting the program without any appreciable educational gains.

If a Type II error is made the situation is quite different. A Type II error consists of the acceptance of a false hypothesis. This means accepting the notion that the two groups are alike with respect to the criteria being considered, when, in fact, they are not. If the two groups of teachers are not exactly alike, one of the procedures (i.e., the inquiry-centered or the textbook-centered) is superior to the other. But if a Type II error is made, we falsely accept that one procedure is as effective as the other and discontinue one of them. Since the new experimental procedure is the one which will probably be discontinued, and assuming that it is the one which in fact is superior, all educational progress is stopped by its discontinuance.

After considering all consequences of the types of errors, the decision was made to minimize Type I because it was determined to minimize the chance of accepting the notion that the inquiry-centered teachers are more effective than the textbook-centered teachers, when, in fact, one type of education may be as effective as the other. In order to minimize these chances the level of confidence was set at the 0.05 level.

CHAPTER II

COMPARING TEACHERS BY EXPERIENCE AND DEGREES HELD

Many educators have advocated that the main criteria for the improvement in science in the elementary school is to require more college hours in science. According to Kleinman reporting on a study by Victor:

> The greatest stumbling block to an effective science program is the reluctance of teachers to teach science because of the inadequacy of their science backgrounds.[1]

Oberlin speaking in a manner similar to Kleinman has indicated that:

> Many graduates in elementary education are not adequately prepared in subject matter to teach elementary school science.[2]

The investigator, along with others, does not agree that an increase of college hours in science per se will necessarily improve elementary school science teaching; but rather the types of experiences had in the content and methods courses

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[1]Gladys S. Kleinman, "Needed: Elementary School Science Consultants," School Science and Mathematics, Vol. LXV, No. 8, (November, 1965).

[2]Lynn Oberlin, "Science Content Preparation of Elementary Teachers," School Science and Mathematics, Vol. LXIX, No. 3, (March, 1969), p. 208-209.

are of great importance. Groff reporting on self-estimates of pre-service elementary teachers indicates that:

> The students overwhelmingly believed that reading was their best subject, and preparation for teaching this subject, as well as teaching arithmetic and spelling, which are not taught in elementary school at the level learned in college, comes almost entirely through methodology courses and student teaching.[3]

Experience in teaching can be gained in a number of ways. Teaching for many years does not necessarily mean a gain in worthwhile experience. By the same token, the continued use of incorrect methods cannot lead to an improvement of teaching elementary school science. Also, the obtaining of advanced degrees is no guarantee that a person's teaching effectiveness will increase. This investigator believes that education in the proven methods of teaching are of prime importance if one is to be successful.

Years Taught in Elementary Grades

In this study the number of years per grade each teacher had taught elementary school and the number of years each had taught elementary school science was determined for both the textbook-centered and the inquiry-centered teachers. The types of degrees with their majors and minors was, also, determined for both groups of teachers. These determinations were made in order to find out if the

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[3]Patrick J. Groff, "Self-Estimates of Teaching Ability in Elementary School Subjects," Journal of Teacher Education, Vol. XIII, No. 4, (December, 1962), p. 421.

textbook-centered teachers differed in experience, number of years of teaching and degrees held from the inquiry-centered group. The study further provided information on the opinions of the two groups of teachers in regard to their experiences through college preparation and their opportunities to make improvements in teaching elementary school science, now that they are in the field.

The data in Graph 1, show the average number of years the textbook-centered and the inquiry-centered teachers have taught in the elementary grades. The two groups show identical number of years of elementary teaching experience in the first and the fifth grades. The textbook-centered teachers show seven more years of experience at the second grade level, and two years more in the fourth grade than the inquiry-centered teachers. The inquiry-centered teachers had nine more years' experience than the textbook-centered teachers at the sixth grade level. The overall average of teaching experience in the six elementary grades, however, shows a difference of only a half year in favor of the textbook-centered group. There is, therefore, no appreciable difference, as far as experience is concerned, in the number of years of teaching experience between the two groups of teachers.

Years Taught Elementary Science

The analysis of the data in Graph 2 showing the average number of years the textbook centered and the

inquiry-centered teachers have taught science in the elementary school, indicates that the former group had one more year of teaching experience in elementary science teaching in the first grade, three more years in the fourth grade, and two years more at the fifth grade level. The inquiry group had eight more years of experience in teaching elementary school science than the textbook-centered teachers in the sixth grade. The average difference in these comparisons of years of teaching elementary school science shows one year in favor of the textbook-centered over the inquiry-centered teachers. In view of this small difference, the two groups appear to be similar with respect to experience in teaching elementary school science.

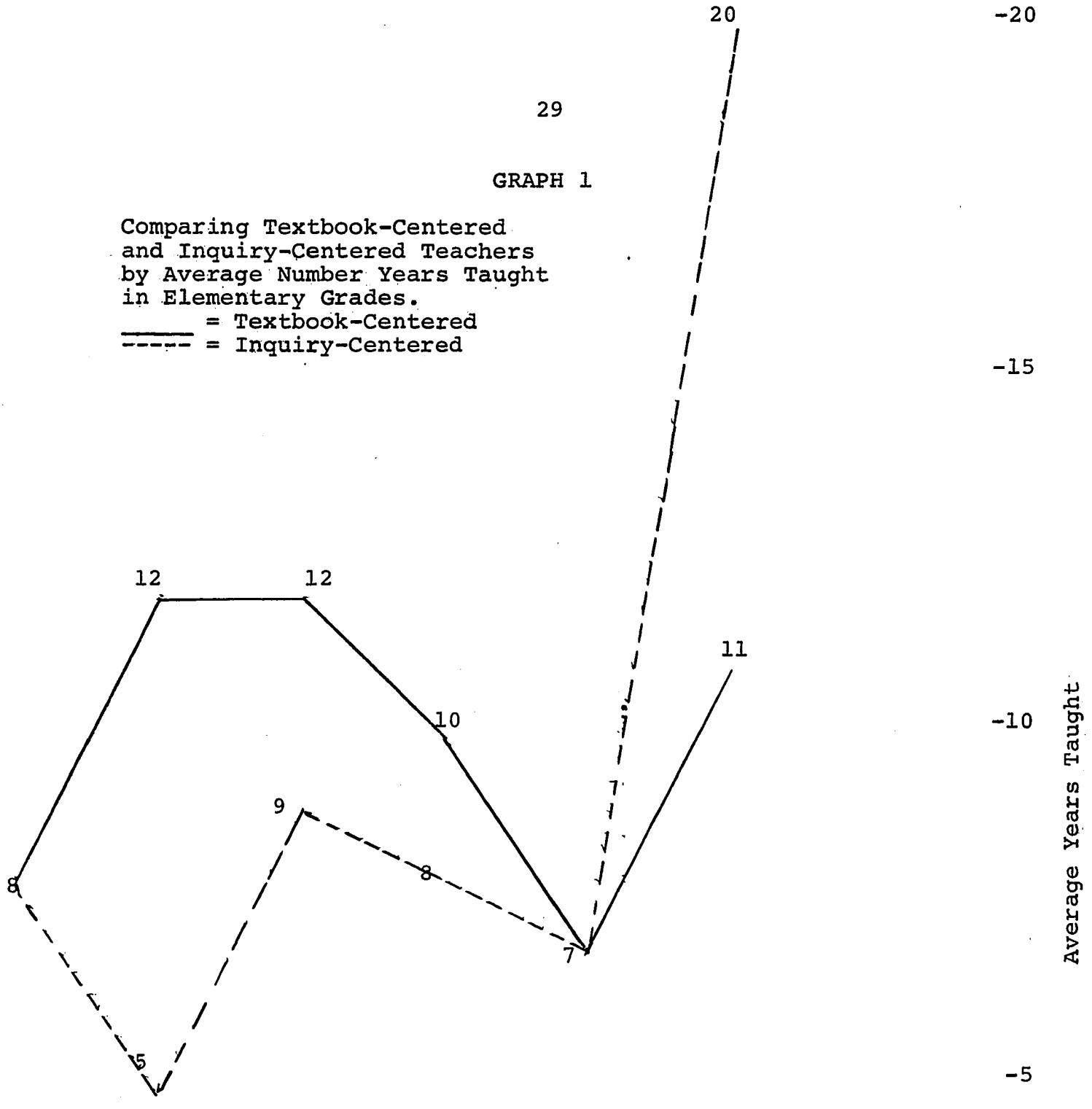
Comparison of Degrees Held

Of the 218 respondents of the textbook-centered and the 41 inquiry-centered teachers all held the bachelor degree; these data are shown in Graph 3.

In reference to the data in Graph 4, the textbook-centered teachers show ten per cent more masters degrees at the first and second grade levels and nine per cent more masters degrees in the fifth grade than the inquiry-centered teachers. The inquiry-centered group show fifty-one per cent more masters degrees at the third grade level and eight per cent more masters degrees at the sixth grade level than the textbook-centered teachers. In the fourth

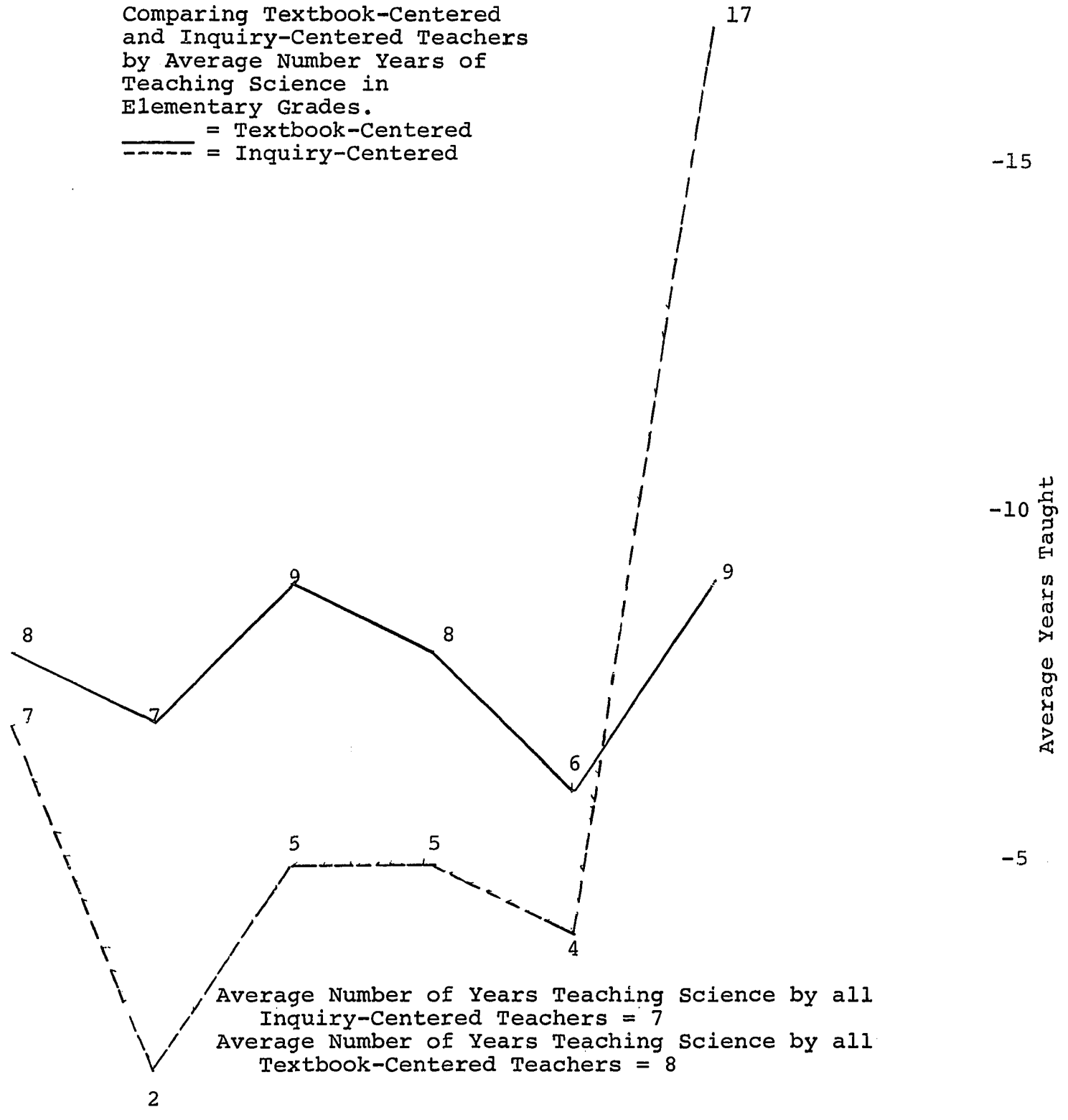
GRAPH 1

Comparing Textbook-Centered
and Inquiry-Centered Teachers
by Average Number Years Taught
in Elementary Grades.
_____ = Textbook-Centered
----- = Inquiry-Centered



Average Experience by all Inquiry-Centered Teachers = 9 1/2 years.
Average Experience by all Textbook-Centered Teachers = 10 years.

GRAPH 2

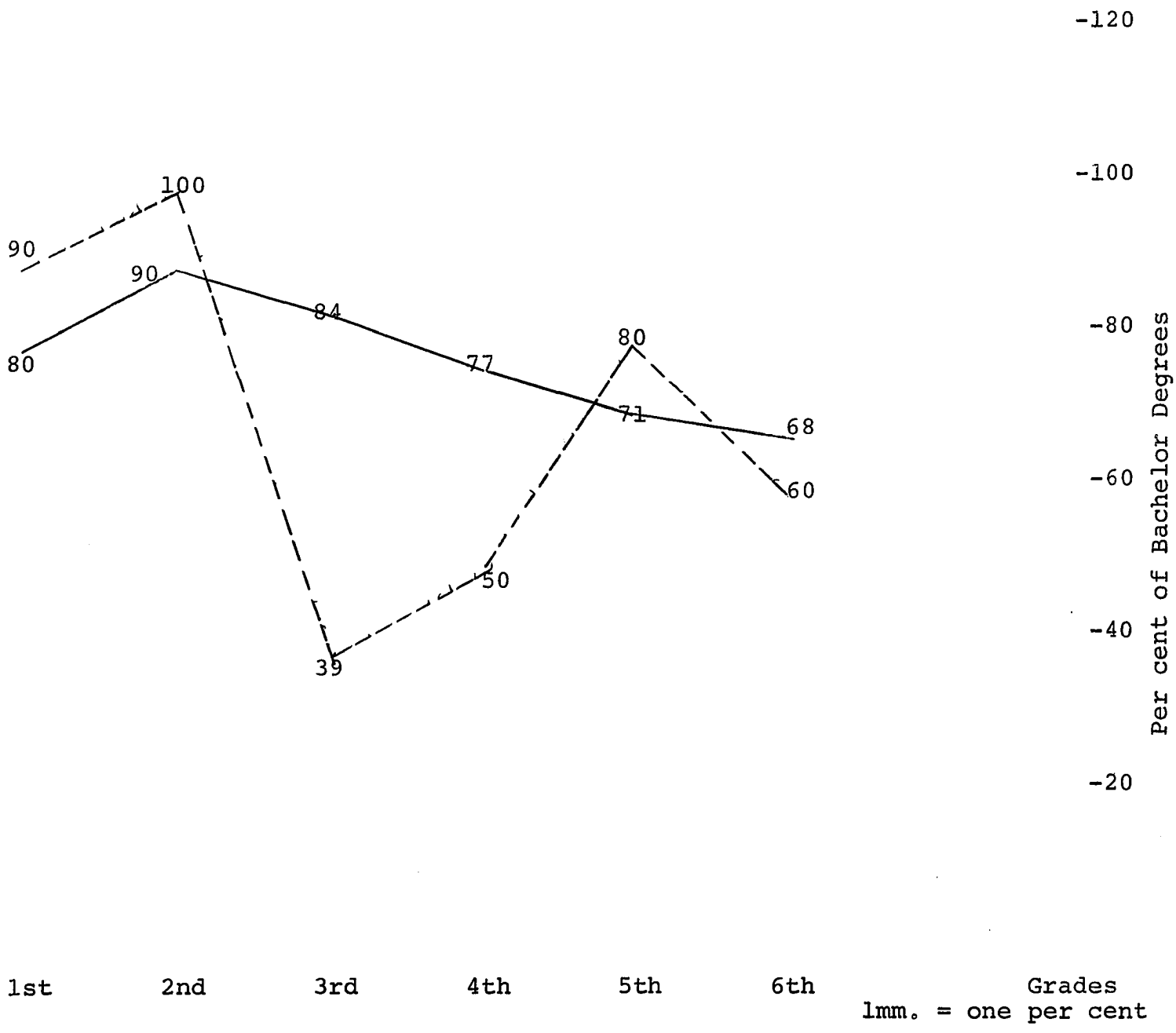

Comparing Textbook-Centered and Inquiry-Centered Teachers by Average Number Years of Teaching Science in Elementary Grades.
_____ = Textbook-Centered
----- = Inquiry-Centered
-20
-15
-10
-5
Average Years Taught
17
9
8
8
9
7
7
6
5
5
4
2
Average Number of Years Teaching Science by all Inquiry-Centered Teachers = 7
Average Number of Years Teaching Science by all Textbook-Centered Teachers = 8
1st
2nd
3rd
4th
5th
6th
Grades
10mm = one year

GRAPH 3

Comparing Textbook-Centered and Inquiry-Centered Teachers by Per Cent of Bachelor Degrees Held

_____ = Textbook-Centered

----- = Inquiry-Centered

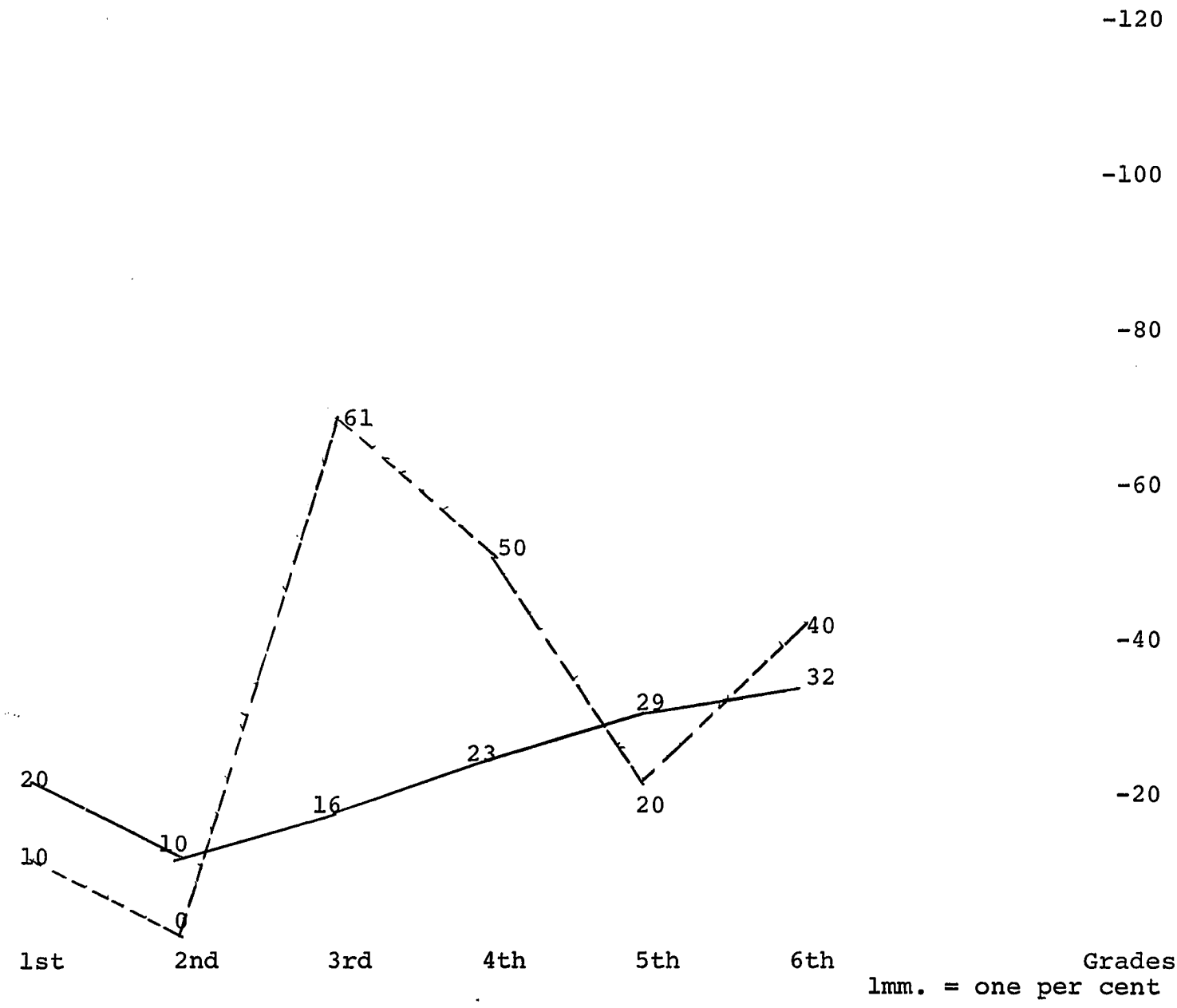


GRAPH 4

Comparing Textbook-Centered and Inquiry-Centered Teachers by Per Cent of Master Degrees Held

_____ = Textbook-Centered

----- = Inquiry-Centered



grade, the inquiry group have twenty-seven per cent more masters degrees, thus three of the grades of the textbook-centered group have more masters degrees and the balance of the other three grades showing masters degrees are in the inquiry-centered group.

Additional information in regard to degrees held is revealed in Tables 1 and 2. Twenty-two per cent of all the textbook-centered teachers hold masters degrees and thirty-three per cent of all the inquiry-centered teachers have the same degree.

Table 3 contains the resultant t-statistics that were derived from an analysis of the per cent of masters degrees held by the two groups of teachers. The t-test for comparison of observed data was the statistical instrument used for analysis of data. The level of confidence for t was set at the 0.05 level. The formula for computing the t-value is as follows:[4]

$$t = \frac{P_1 - P_2}{\sqrt{\frac{P_1 q_1}{N_1} + \frac{P_2 q_2}{N_2}}}$$

where P_1 = per cent of group one that possess some trait

q_1 = per cent of group one that does not possess the trait

P_2 = per cent of group two that possess some trait

q_2 = per cent of group two that do not possess the trait

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[4]Robert H. Koenker, Simplified Statistics, (Bloomington, Illinois: McKnight & McKnight Publishing Company, 1961), p. 100.

TABLE 1

TEXTBOOK-CENTERED TEACHERS

DEGREES--MAJORS AND MINORS

Bachelor		Master	
Major	Minor	Major	Minor
FIRST GRADE			
Elementary-23 History-3 Home Economics-3 Business-1 Music-2 Mathematics-1	Art-3 Health Education-1 English-7 Music-1 Home Economics-1 Psychology-1 Business-2 Physical Education-3 History-3 Social Studies-1 Science-2 Elementary-3 Education-1	Elementary-5 Administration-1 Education-1	Physical Education-1 Music-1 Science-1
SECOND GRADE			
Elementary-19 Home Economics-2 Art-1 Biology-1 English-2 Psychology-1 Social Studies-1 History-1	English-5 Business-2 Speech-2 Elementary-4 Psychology-2 Art-1 Mathematics-1 History-3 Social Studies-2 Language-1 Home Economics-1 Music-1	Elementary-3	Social Studies-1

TABLE 1--Continued

THIRD GRADE			
Elementary-21	Elementary-6	Elementary-6	
English-3	Social Studies-3		
History-1	Home Economics-4		
Home Economics-3	English-5		
Art-1	Business-2		
Biology-1	History-3		
Business-1	Spanish-1		
	Physical Education-1		
	Journalism-1		
	Art-2		
	Science-2		
	Psychology-1		
FOURTH GRADE			
Elementary-22	History-2	Elementary-6	Psychology-1
Business-1	Home Economics-2	English-1	
Agronomy-1	Elementary-3		
Music-1	Soils-1		
Art-2	Psychology-1		
Speech-1	Social Studies-3		
English-1	English-6		
Psychology-1	Art-1		
Home Economics-1	French-1		
	Science-2		
	Biology-1		
FIFTH GRADE			
Elementary-15	Biology-1	Elementary-8	Elementary-1
Business-3	Elementary-7	Business-1	English-1
Agriculture-2	English-4		Administration-1
Physical Education-1	Social Studies-4		
Biology-1	Science-3		
Science-1	Chemistry-2		
Industrial Arts-1	Home Economics-2		
Mathematics-1	Journalism-1		

TABLE 1--Continued

FIFTH GRADE--Continued			
Social Studies-1	History-2		
Home Economics-2	Psychology-2		
Art-2	Business-1		
English-1	Physical Education-1		
SIXTH GRADE			
Industrial Arts-1	Agriculture-2	Elementary-7	Elementary-1
Elementary-20	Home Economics-4	Administration-1	Art-1
Agriculture-1	Science-3		Government-1
English-1	History-6		
Home Economics-3	Elementary-4		
Physical Education-1	Social Studies-4		
Social Studies-7	Biology-1		
History-1	Physical Education-5		
Science-1	Art-1		
	Speech-1		
	Mathematics-1		
	Economics-1		

TABLE 2

INQUIRY-CENTERED TEACHERS

DEGREES--MAJORS AND MINORS

Bachelor		Master	
Major	Minor	Major	Minor
FIRST GRADE			
Elementary-9 English-1	Drama-1 History-1 Psychology-1 Social Studies-2 English-1 Art-1	Elementary-1	Special Education-1
SECOND GRADE			
Elementary-5 Music-1	Elementary-1 French-1 Social Studies-1		
THIRD GRADE			
Elementary-2 Business-1		Elementary-2	
FOURTH GRADE			
Elementary-3 English-1	Art-1 Business-1 Physical Education-1	Elementary-2	
FIFTH GRADE			
Elementary-3 Business-1 Speech-1	French-1 Elementary-1 Language Arts-1 Drama-1 Business-1	Elementary-1	

TABLE 2--Continued

SIXTH GRADE		
Home Economics-1	Science-2	Elementary-2
Elementary-1	Home Economics-1	
History-1	Mathematics-1	
Science-2	Elementary-1	
English-1		

TABLE 3

COMPARISON OF PER CENT OF MASTERS DEGREES HELD BY TEXTBOOK-CENTERED AND INQUIRY-CENTERED TEACHERS

	Holding Masters		Not Holding Masters		Total	
	No.	Per Cent	No.	Per Cent	No.	Per Cent
Inquiry Centered	14	33	27	67	41	100
Textbook Centered	58	22	160	78	218	100

t = 1.399

A value of the t-test of 1.970 or greater was required for significance. A t-score for comparison of percentages of 1.399 was obtained for the masters degrees. This fell below the established level of confidence at the 0.05 level and was interpreted to show no statistical difference. Therefore, there is no difference between the two groups of teachers in respect to advanced degrees.

Comparison of Major Areas

The data in Tables 1 and 2 also reveal that of the textbook-centered teachers, five indicated science as a major for the bachelor degree and none indicated science for the master degree. Twenty showed some type of science as a minor for the undergraduate work and one a minor for the masters degree. Of the 41 inquiry-centered teachers, two indicated science as a minor for the bachelor degree and none

showed science as a major for the masters degree. The two groups show relatively little difference in regard to pursuing either a major or minor in science in their college education. The fact that the two groups (inquiry-centered and textbook-centered teachers) are very similar in their educational backgrounds in regard to science makes for excellent comparison possibilities.

Not all the teachers in this study were elementary education majors. Sixty-three per cent of the textbook-centered teachers majored in elementary education for the bachelors degree and sixty-two per cent majored in elementary education for the masters degree. Some of the major areas included were: history, home economics, business, music, mathematics, art, biology, psychology, social studies, English, agronomy, speech, physical education, natural science, and industrial arts. Seventy per cent of the inquiry-centered teachers majored in elementary education in the bachelors degree and sixty-three per cent majored in elementary education in the masters degree. Some of the other areas for the major included: English, music, business, speech, home economics, history, and science. These data, regarding majors in elementary education, show additional evidence that the two groups of textbook-centered and inquiry-centered teachers are closely related as to their formal educational experiences. Sixty-two per cent versus sixty-three per cent in favor of the inquiry-centered

teachers over the textbook-centered teachers in regard to majoring in elementary education for the masters degree. These comparisons, too, indicate the similarity between the two groups.

Experience During College Years

In this study the decision was made to examine the two groups of teachers on the basis of their satisfaction and dissatisfaction in regard to experience gained during their college years and, also, those opportunities to gain experience, now that they are in the field, that might prove of value in improving elementary science teaching. Table 4 contains the resultant t-statistics that were derived from an analysis of the per cent satisfaction and dissatisfaction of college preparation experience. Again, a t-value of 1.970 or greater was required for significance. From the data in Table 4 two of the categories were considered statistically significant: (1) For the category college methods courses a t-score of 4.031 was obtained in favor of the inquiry-centered teachers. That value is significant. (2) For the category of motivation toward a wholesome attitude for science teaching, a t-score of 2.078 was derived; this could also be considered significant; both of these differences were in favor of the inquiry-centered teachers.

These statistically significant data appear to support the investigator's belief that the inquiry-centered

teachers gained more valuable experiences from having received education in the inquiry methods courses. At the same time, the data tend to repudiate the contentions of Kleinman, Victor and Oberlin that the ineffectiveness of elementary science teaching can be overcome, only, by an increase of science content in the education of elementary science teachers. These data suggest that the inquiry-centered teachers are better grounded in the methods of teaching elementary school science and have a more wholesome attitude toward science teaching than the textbook-centered teachers. The probability is, therefore, that they would perform in a manner more conducive to the attainment of the elementary school science objectives.

The same procedure was used for determining the per cent satisfaction and dissatisfaction for content, subject matter, and area of experience for the two groups now in the field. The results of this analysis of data are shown in Table 5. In all five categories investigated a t-score of 1.970 or greater was obtained. The difference in every category was in favor of the inquiry-centered teachers.

The data in Table 5 seem to indicate that the inquiry-centered teachers are more alert to the possibilities of gaining experience in regard to improvement of subject matter, selecting science content, and securing and adapting technical materials than are the textbook-centered

TABLE 4

COMPARISON OF COLLEGE PREPARATION OF TEXTBOOK-CENTERED AND INQUIRY-CENTERED TEACHERS

	Textbook-Centered Per Cent		Inquiry-Centered Per Cent		
	Satisfied	Not Satisfied	Satisfied	Not Satisfied	t
College Science Subject Matter Courses	49	51	64	36	1.823
Quantity of Laboratory Science Courses	42	58	56	44	1.659
College Methods Courses in Science	42	58	73	27	4.031*
Adequate Coverage of Biological Science	55	45	54	46	0.118
Adequate Coverage of Physical Science	50	50	49	51	0.118
Motivation Toward a Wholesome Attitude for Teaching Science	57	43	73	27	2.078*

*Significant at the 0.05 level.

teachers. The investigator believes these advantages are the result of the educational background they received by the inquiry-method of teaching elementary school science. This appears to indicate a poor educational background from science and education on the part of the textbook-centered teachers.

Summary

The two groups of teachers investigated are very similar with respect to the number of years taught in elementary grades and the number of years experience in teaching elementary school science. There is, also, a noticeable similarity in regard to the educational backgrounds of the two groups of teachers.

However, the two groups show a significant difference in regard to their having profited by the course in methods of science teaching and having obtained a wholesome attitude toward science teaching while a student. The differences found in satisfaction were in favor of the inquiry-centered teachers. In the opinion of the investigator, these two attitudes are of great importance to the success of an elementary school science program. Another significant difference in favor of the inquiry-centered teachers, is the ability or "know how" they seem to have over the textbook-centered teachers in being able to take advantage of such categories as those listed in

Table 5. The investigator feels that these differences are due to the fact that the inquiry-centered teachers had education in the inquiry-method of teaching science. The inquiry-centered teacher's interest in science seems to be more intense than that of the textbook-centered teacher.

TABLE 5

COMPARISON OF CONTENT SELECTION, SUBJECT MATTER AND USE OF TECHNICAL MATERIALS OF TEXTBOOK-CENTERED AND INQUIRY-CENTERED TEACHERS

	Textbook Centered Per Cent		Inquiry Centered Per Cent		
	Satisfied	Not Satisfied	Satisfied	Not Satisfied	t
Opportunity to Improve Your Science Background	41	59	88	12	7.755*
Ability to Obtain Non-Technical Materials	23	77	68	32	5.754*
Ability to Obtain Information on Science Workshops, In-Service Offerings and Short Courses	42	58	90	10	8.348*
Ability to Adapt Technical Materials to the Level of Pupils	39	61	83	17	6.092*
Freedom to Select Science Content	67	33	88	12	3.506*

*Significant at the 0.05 level

CHAPTER III

SELECTION OF SCIENCE CONTENT AND FACILITIES

Selection of science content is essential to all areas of learning and the content of science instruction is no exception. Many science teaching materials convey the idea that science should consist of factual information to be remembered by the students; few recognize that science content should provide the student with experiences which will lead him to an understanding of his environment. Since teachers help select and use the materials, perhaps the foregoing statement also expresses their beliefs about what science content really is. Bruner, according to Fish, points out:

> Content should guide the child to extend, to clarify, and to refine his concepts concerning the environment by guiding him to systematically examine and test environmental relationships.[1]

Many educators are concerned over the loss of interest in inquiring as pupils reach the upper elementary and junior high grades, and many relate this loss of interest to the content used. According to Ragan:

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[1]A. S. Fish, "Structuring an Elementary School Science Program," The Elementary School Journal, Vol. 63, (February, 1963), pp. 277-280.

> There can be little doubt that the schools' emphasis upon accepting the word of the teacher and the textbook accounts for a large part of this loss.[2]

Content should aid pupils in understanding their environment and encourage their natural curiosity and love of inquiry. Elementary school science content must be constantly re-evaluated and revised. In the past the guidelines for elementary school science have emphasized the product approach, which was recommended by the State Science Committee of the Oklahoma Curriculum Improvement Commission of 1960. This approach seems to account for most of our present day elementary school programs being subject-matter centered. In many instances the updating or revision of science programs consisted of making the courses "tougher". The result has been an increase in content which consisted of subject matter and materials which were above the intellectual level of the learners being taught. This type of program can only lead to increased memorization of more and more facts. The elementary school science program must include process as well as content. The program should have a scope and sequence and should, also, parallel the growth patterns of the pupils. According to Renner and Ragan:

> Learning experiences in the area of elementary school science should be selected in terms of valid criteria:
>
> (1) The content selected should have the potential of leading the pupil to develop his rational powers,

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[2]William B. Ragan, Modern Elementary Curriculum, (New York: Holt, Rinehart and Winston, 1966), p. 367.

(2) when the pupil has completed his study of content, he should have improved his understanding of his environment,

(3) learning activities and content selected must result in classroom experiences which can be recognized as science by a scientist.[3]

The individuals who are held responsible for the Oklahoma elementary school science program need to keep themselves informed of the 1968 guidelines of the State Science Committee of the State Department of Education. Those guidelines for Oklahoma were spelled out in Chapter I of this study. Accepting those criteria as objectives, the structure of the science program should be designed in order to accomplish them.

This research compared the two groups of teachers studied with regard to the selection of science content in order to find out if the content selection of one group was superior to the other group in providing opportunities by which the established objectives could be achieved.

Sources of Science Content Selection

The data in Table 6 show that there are many variations by which the selection of elementary science content is made. Fifty-three per cent of the inquiry-centered teachers indicated that they were assisted by the regional director of the SCIS project in their selections of elementary science content. The balance of the group is

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[3]Renner and Ragan, "Teaching Science Elementary School," p. 157.

as follows: eight per cent by school superintendent, nineteen per cent by committee, eleven per cent by grade teacher, three per cent by elementary principal, three per cent by school superintendent, committee, grade teacher and elementary principal, and three per cent by school superintendent, committee and grade teacher.

The textbook-centered teachers indicate that thirty-eight per cent of the elementary science content is decided by committee, while thirty-two per cent is done by the grade teacher. The balance of the other decisions consists of small percentages distributed through various choices of selection. The textbook-centered teachers related various avenues by which they selected their science content. All of the textbook-centered teachers indicated that they were using a science textbook, or textbooks, in their elementary science programs. Therefore, it is the opinion of the investigator that in the final analysis the textbook serves this group of teachers as the source of content.

Textbooks Used

Table 7 lists the percentage of various textbooks used by the textbook-centered teachers. Twenty per cent were using textbooks published by Laidlaw Brothers, and another twenty per cent were using Harcourt, Brace and World texts. The majority (thirty-seven per cent) used one of the texts published by D. C. Heath and Company.

TABLE 6

SELECTION OF SCIENCE CONTENT

	Per Cent Textbook-Centered	Per Cent Inquiry-Centered
(a) School Superintendent	4	8
(b) Committee	38	19
(c) Grade Teacher	32	11
(d) Elementary Principal	9	3
(e) Others* (Mainly Regional Director of SCIS)	2	25
(c and d) Grade Teacher and Elementary Principal	6	0
(a, b and e) School Superintendent, Committee, and Others*	1	14
(a, b, c, and d) School Superintendent, Committee, Grade Teacher, and Elementary Principal	1	3
(b and c) Committee and Grade Teacher	3	0
(b and d) Committee and Elementary Principal	2	0
(a, b, and c) School Superintendent, Committee, and Grade Teacher	0	3
(c, d, and e) Grade Teacher, Elementary Principal and Others*	0	3
(c and e) Grade Teacher and Others*	0	3
(a and c) Superintendent and Grade Teacher	2	0
(a and e) School Superintendent and Others*	0	3

TABLE 6--Continued

	Per Cent Textbook-Centered	Per Cent Inquiry-Centered
(a, d, and e) School Superintendent, Elementary Principal and Others*	0	5
	100	100

*Others--indicate Regional Director of SCIS Project

Ginn and Company, Harper and Row, Silver Burdett Company and Singer were used in smaller percentages by the teachers. All of these books are on the Oklahoma State adoption list.

According to Moorehead, as reported in Chapter I of this study, the textbook-centered teachers are teaching content and omitting the process part of the elementary school science programs.[4] He, also, adds:

> The conventional material in elementary school science is fact-centered. The objectives of these materials, however, are process-centered, which means that the material as presented in the books does not achieve the objectives. . . . the materials and the way they are presented offer no opportunity for the students to develop his rational powers.[5]

The investigator, through numerous visitations with elementary teachers in the fifteen counties served by Northeastern State College, concludes that many conscientious teachers face serious conflict in the selection of elementary science content, and they believe that once a textbook from the State Textbook Commission list is selected and presented to them, that it then becomes "law", and they do not feel free to deviate from it in conducting their elementary science programs. Therefore, the selection of content is determined to a large extent from said textbooks with the result that many times the pupils are improperly guided in their pursuit of science and soon lose

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[4]Moorehead, "Status of Elementary School Science," p.100.

[5]Ibid.

TABLE 7

PER CENT OF TEXTBOOKS USED BY TEXTBOOK-CENTERED TEACHERS

Title	Publisher	Per Cent Used By Teachers
Experimenting in Science	Ginn and Company	1
Today's Basic Science	Harper and Row	12
Silver Burdett Science Program	Silver Burdett Company	7
Discoveries in Science	Singer	3
The Laidlaw Science	Laidlaw Brothers	20
Concepts in Science	Harcourt, Brace & World	20
Schneider Series	D. C. Heath Company	37
		100

their natural curiosity about science. The investigator feels that this procedure in the selection of science content may interfere with the proper establishment of curricula, which may prove to be more suitable than those which are apparently being used at the present time.

It seems significant that the inquiry-centered teachers are critically guided in their choices of science content by an expert in the field of science education; whereas, the textbook-centered teachers receive little expert guidance in comparison with that received by the inquiry-centered teachers. It appears that any guidance the textbook-centered teachers receive is from individuals who have not had education in the inquiry method of teaching elementary school science.

Physical and Library Facilities

In order to properly conduct an elementary school science program, suitable facilities should be made available. This study also compared the textbook-centered teachers to see if their opinions differed in regard to their satisfaction or dissatisfaction of (1) the physical facilities, and (2) the library facilities. The investigator believes these facilities to be tantamount in the achievement of the objectives of the elementary school science program.

By an analysis of the data in Table 8, six of the seven categories reveal t-scores above 1.970. The inquiry-

centered teachers are better satisfied with the size of science classrooms, availability of electrical outlets, availability of water for experiments, availability of worktables, availability of heat for experiments, and availability of preparation table or room for science materials than the textbook-centered teachers. However, the inquiry-centered teachers indicate that they are still not satisfied, as revealed by the high per cent indicating (not satisfied) in four of the categories. There is no statistical difference between the two groups of teachers in only one category--that of shelving for science materials--both groups show a relatively high per cent of dissatisfaction with available shelving. From these data it seems that both groups could provide stronger elementary school science programs by obtaining cooperation and assistance through their school administrations. It appears that the financial support of the inquiry-centered teachers is greater than that of the textbook-centered teachers. The investigator feels that this difference in financial support is a direct result of the increased enthusiasm displayed by the inquiry-centered teachers.

According to the data in Table 9 t-scores in four of the five categories were determined and found to be significant; i.e., the t-value was greater than 1.970. These four categories were significant in favor of the inquiry-centered teachers. Therefore, the inquiry-centered

TABLE 8

COMPARISON OF PHYSICAL FACILITIES FOR TEXTBOOK-CENTERED AND INQUIRY-CENTERED TEACHERS

	Textbook-Centered Teachers		Inquiry-Centered Teachers		
	Satisfied	Not Satisfied	Satisfied	Not Satisfied	t
Size of Classroom for Science	39	61	61	39	2.651*
Shelving for Science Materials	19	81	34	66	1.908
Availability of Electrical Outlets	28	72	54	46	3.110*
Availability of Water for Experiments	38	62	86	14	7.570*
Availability of Worktables	22	78	46	54	2.902*
Availability of Heat for Experiments	18	82	39	61	2.609*
Availability of Preparation Table or Room for Science Materials	16	84	34	66	2.308*

*Significant at the 0.05 level

TABLE 9

COMPARISON OF LIBRARY FACILITIES FOR TEXTBOOK-CENTERED AND INQUIRY-CENTERED TEACHERS

	Textbook-Centered Teachers		Inquiry-Centered Teachers		
	Satisfied	Not Satisfied	Satisfied	Not Satisfied	t
Availability of Reference Material	39	61	58	42	2.389*
Availability of Supplementary Science Books of the Desired Grade Level	37	63	73	27	4.830*
Ability to Evaluate Elementary Science Textbooks and Workbooks	42	58	71	29	3.699*
Availability of Funds for Elementary Library Materials	31	69	46	54	1.788
Provisions for Obtaining Materials from Library for Classroom Use	42	58	66	34	2.955*

*Significant at the 0.05 level

teachers are better satisfied with the availability of reference materials, supplementary science books of the desired grade level, obtaining materials from the library for classroom use, and the ability to evaluate elementary science textbooks and workbooks than are the textbook-centered teachers. There was no significant difference between the two groups in regard to the availability of funds for elementary library materials, both show dissatisfaction in this category. The investigator believes here, again, the ability of the inquiry-centered teachers over the textbook-centered teachers in regard to evaluation techniques and providing for supplemental library materials is due to their having had education in the inquiry method of elementary school science which emphasizes evaluation and re-evaluation of the elementary science programs.

Summary

There does not appear to be any established policy for the selection of elementary school science content. The selection of content by the textbook-centered teachers does not follow procedures that are conducive to the accomplishment of proposed objectives as outlined by the State Department of Education. The selection of content by the inquiry-centered group is guided along procedures that are based upon the proposed objectives of the elementary school science program. The textbook-centered

teachers appear to be lacking in both physical and library facilities and their elementary school science program seems to be subject-matter centered; whereas the inquiry-centered teachers emphasize process as well as subject matter.

CHAPTER IV

TIME DISTRIBUTION

Elementary teachers lament the lack of time for their daily programs. They have been asked to give more and more time to this or that phase of the elementary program and recently they have been confronted with the demand to spend more time teaching science. The difficulty may lie with the unequal distribution of the available time and the elementary teacher may need assistance in order to include elementary science in his busy schedule. Perhaps there are approaches to teaching which could coordinate science with the present curricula which would, in fact, permit more time for science in the elementary program--an activity which many educators feel is vitally important in today's educational program.

Distribution of Time/Week/Grade Spent in Subject Areas

In this study a comparison was made between the textbook-centered teachers and the inquiry-centered teachers with respect to the distribution of time allotted to subject areas by grades. The investigator felt that the amount of instructional time devoted to science could provide real

insight into the importance which a teacher attaches to science in the elementary school curriculum.

The data shown in Graphs 5 and 6 demonstrate that the textbook-centered teachers and inquiry-centered teachers show a decrease, in minutes per week in the amount of time spent in reading and writing from the first grade through the sixth. In regard to reading, the textbook-centered teachers show a decrease of 248 minutes per week on the average and the inquiry-centered teachers a decrease of 280 minutes per week on the average. The textbook-centered group show an average decrease of 36 per week in writing and the inquiry-centered teachers indicate an average decrease of 62 minutes per week. Of the eight subject areas investigated in this study only reading and writing showed a significant decrease in the amount of time spent per week.

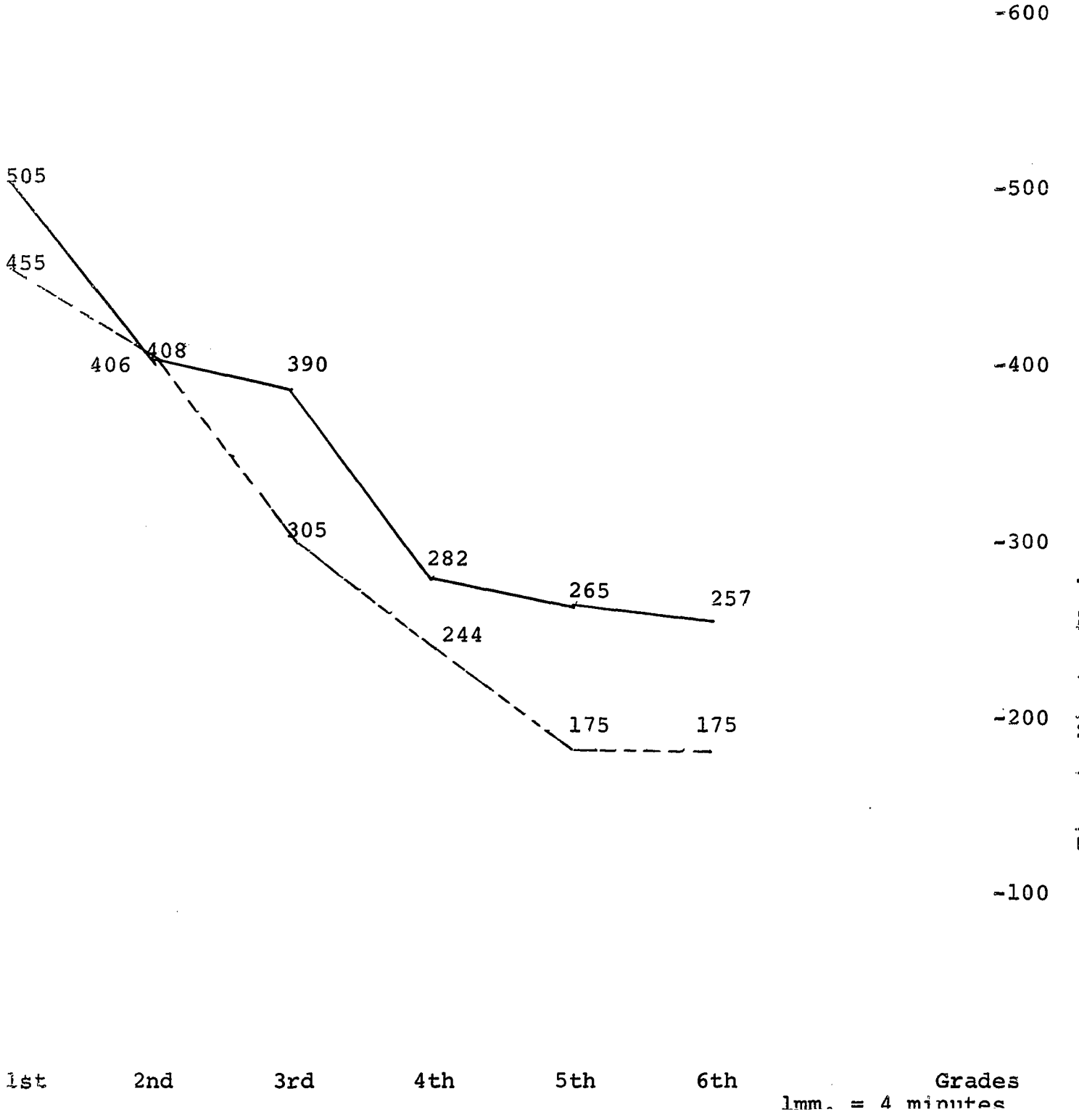
Many educators and lay people have expressed concern in regard to the lack of emphasis being shown for the three R's in the elementary program. Overall, the two groups of teachers show little difference in the time spent in teaching reading and writing. However, both show a continuous decline of time spent on these subjects from the first through the sixth grades. This investigator believes the science program may offer an excellent vehicle by which reading and writing about a science may further the reading and writing capabilities of the pupils. Yet, from the data in Graph 9, the inquiry-centered teachers indicate that

GRAPH 5

Comparing Textbook-Centered and Inquiry-Centered Teachers by Average Time in Minutes/Week/Grade in Reading.

_____ = Textbook-Centered

-----=Inquiry-Centered

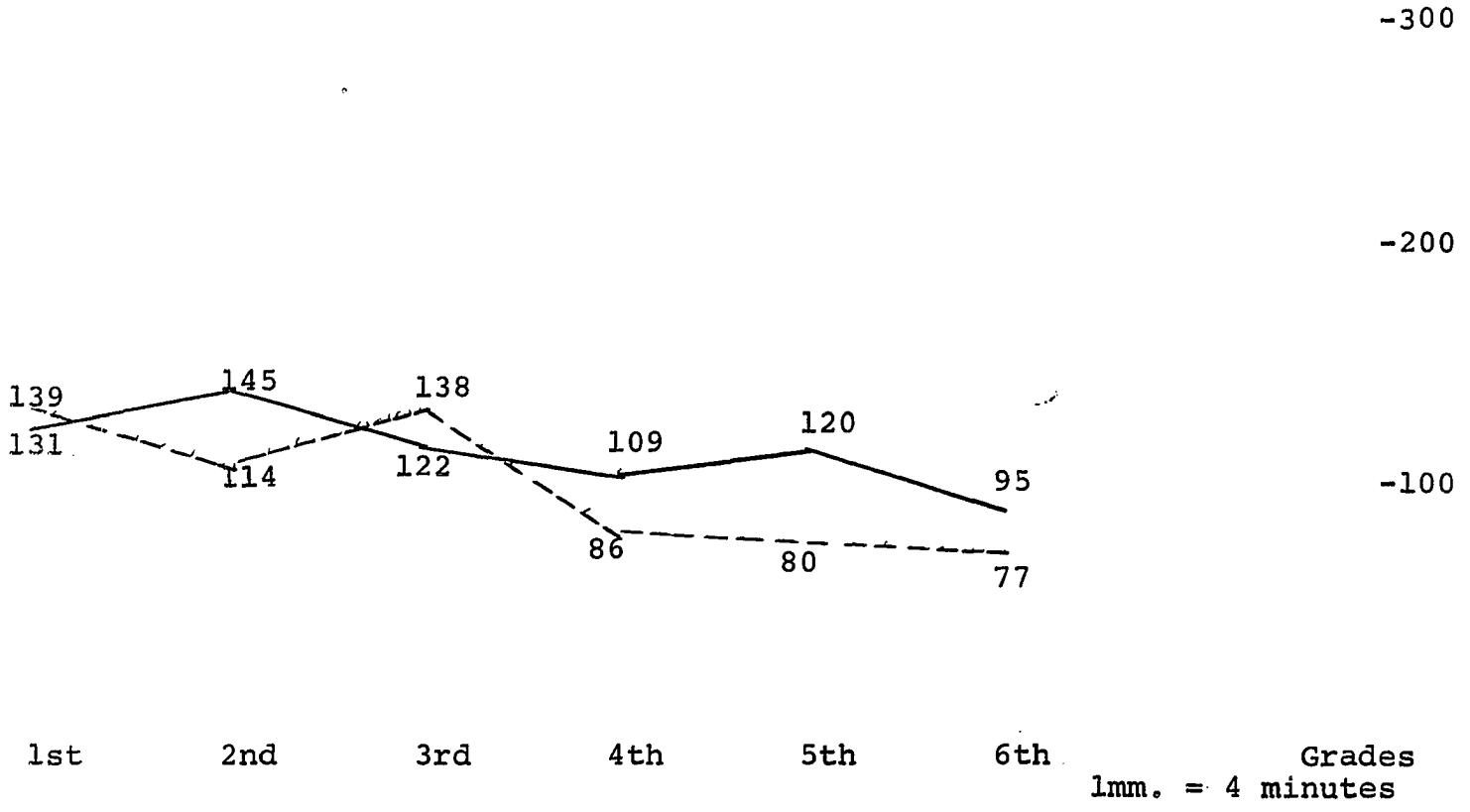


GRAPH 6

Comparing Textbook-Centered and Inquiry-Centered Teachers by Average Time in Minutes/We-k/Grade in Writing

_____ = Textbook-Centered

----- = Inquiry-Centered



they are spending more time on one of the three R's, that of arithmetic, in all six grade levels, than are the textbook-centered teachers. For example, the average time in minutes per week of all the first grade inquiry-centered teachers is 222 minutes; for the textbook-centered teachers in the first grade the average is 90 minutes--indicating an increase of 132 minutes spent on arithmetic by the inquiry-centered teachers in the first grade. The investigator believes that this concern for arithmetic by the inquiry-centered teachers is directly related to their concern for science because of the close relationship of arithmetic and science in teaching the process of problem solving.

The data in Graphs 8, 10 and 12 for both groups of teachers, show a small increase in average minutes per week of all teachers in each grade spent in arts and crafts, music, and physical education from the first through the sixth grades. The greatest increase of time, for both groups, is in social studies and science. From the data in Graph 7, the textbook-centered teachers show an average increase of 132 minutes per week in social studies from the first through the sixth grade, with the peak amount of time of 255 minutes at the fifth grade level. For grades one through six, the inquiry-centered teachers shown an average increase of 104 minutes per week in social studies, with a peak time of 213 minutes, also, at the fifth grade level. As shown in Graph 11, the textbook-centered teachers show

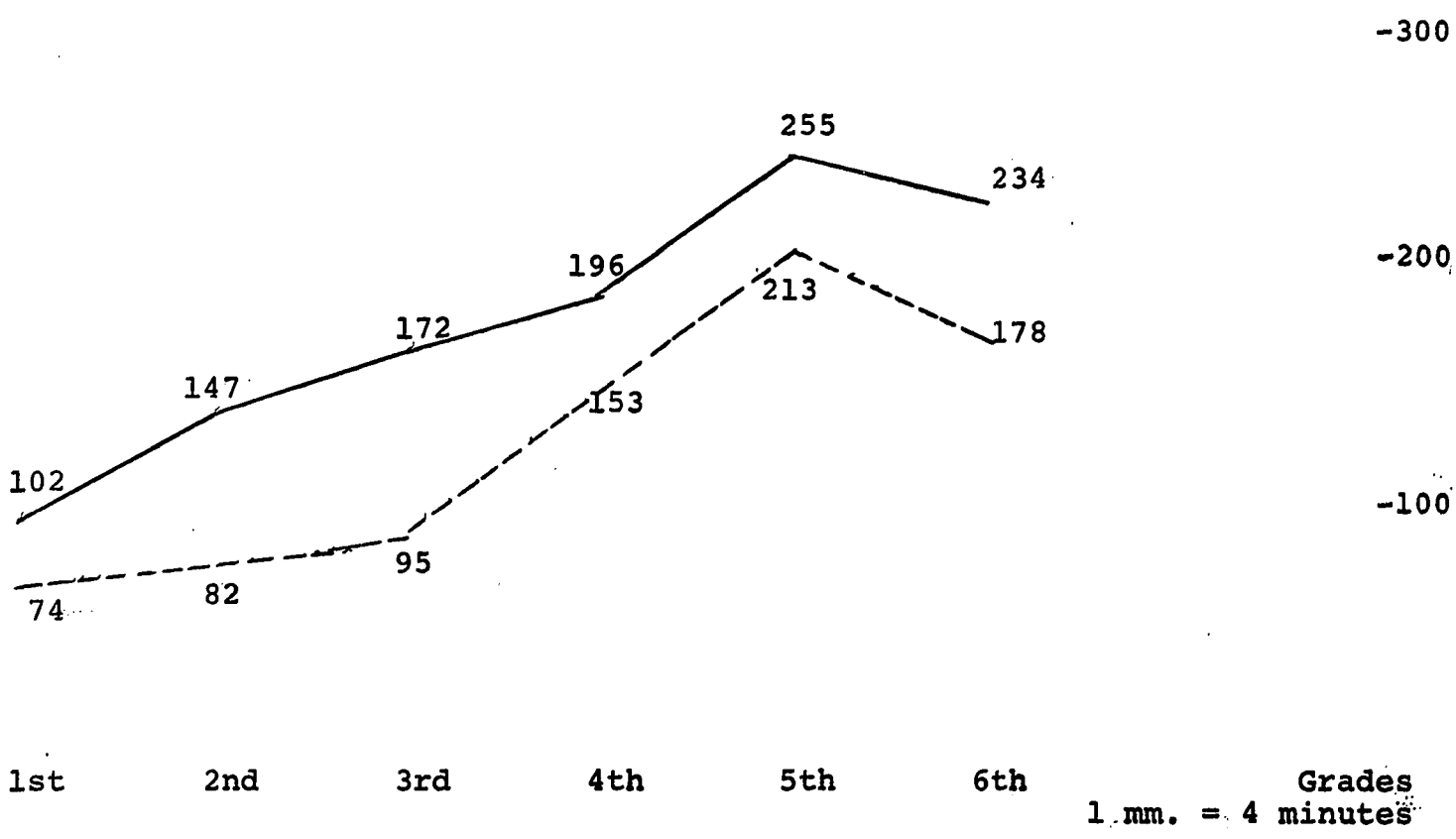
an average increase of 80 minutes per week in science with a peak amount of time of 198 minutes at the sixth grade level. The inquiry-centered teachers shown an average increase of 153 minutes per week in science with a peak amount of time of 274 minutes, also, at the sixth grade level. These data demonstrate that in each grade the inquiry-centered teachers are spending more time teaching elementary school science than the textbook-centered teachers. The investigator believes that this increased time devoted to science by the inquiry-centered teachers is a direct result of their education in methods and their wholesome attitude toward science as it was brought out in Chapter II of this study. Also, this emphasizes the importance that the inquiry-centered teachers attach to science in the elementary school curriculum.

Per Cent of Time Teachers Spend Performing Science Demonstrations

In this study the two groups of teachers were compared with regard to the percentage of time each group devoted to the teachers themselves performing science demonstrations. From the data in Graph 13, the following differences are evident: the textbook-centered teachers in each grade performed a greater percentage of the science demonstrations than the inquiry-centered teachers. The grades with the per cent increases of the textbook-centered over the inquiry-centered teachers is as follows: first

GRAPH 7

Comparing Textbook-Centered and Inquiry-Centered Teachers by Average Time in Minutes/Week/Grade in Social Studies
_____ = Textbook-Centered
----- = Inquiry-Centered

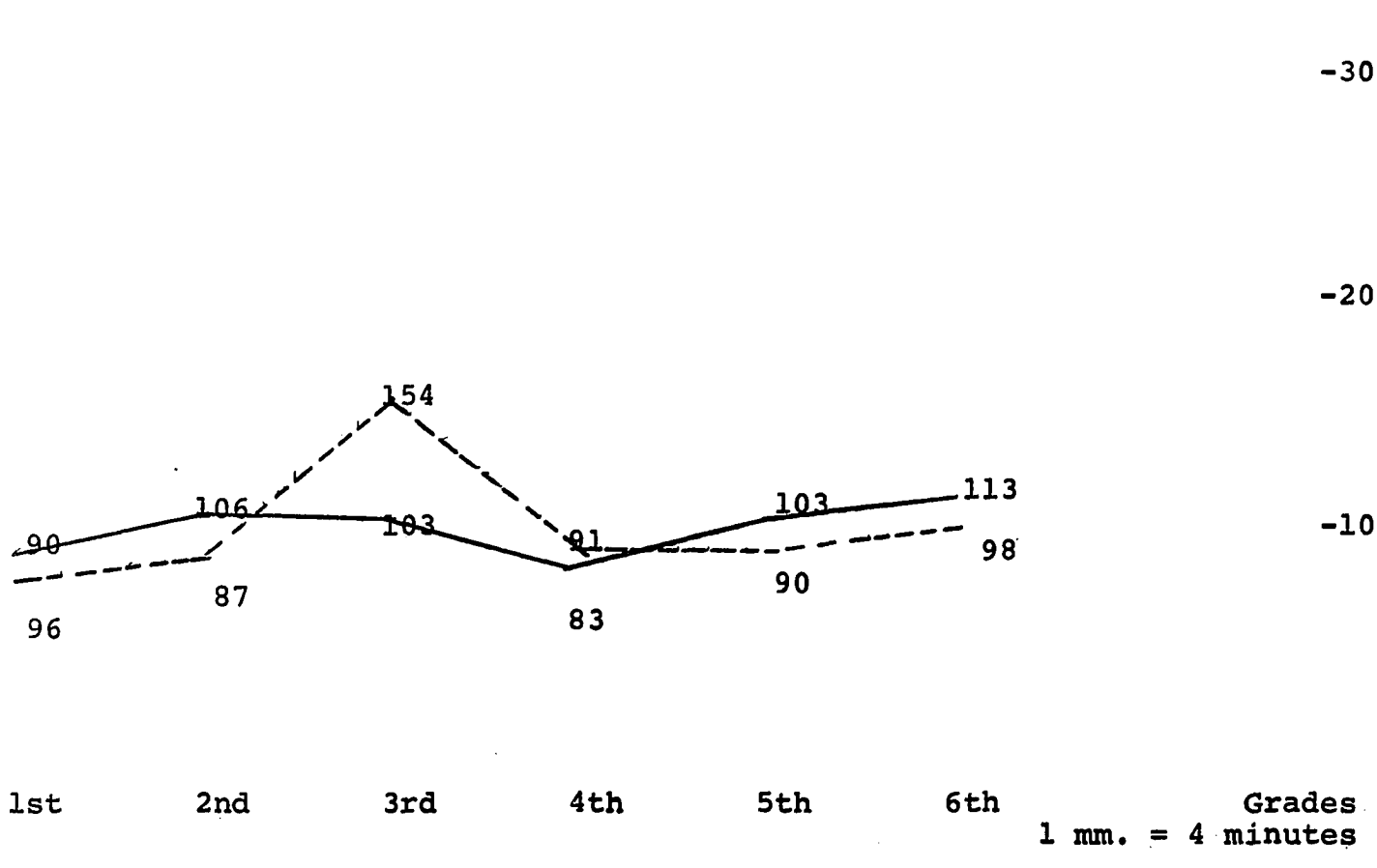


GRAPH 8

Comparing Textbook-Centered and Inquiry-Centered Teachers by Average Time in Minutes/Week/Grade in Arts and Crafts

_____ = Textbook-Centered

----- = Inquiry-Centered

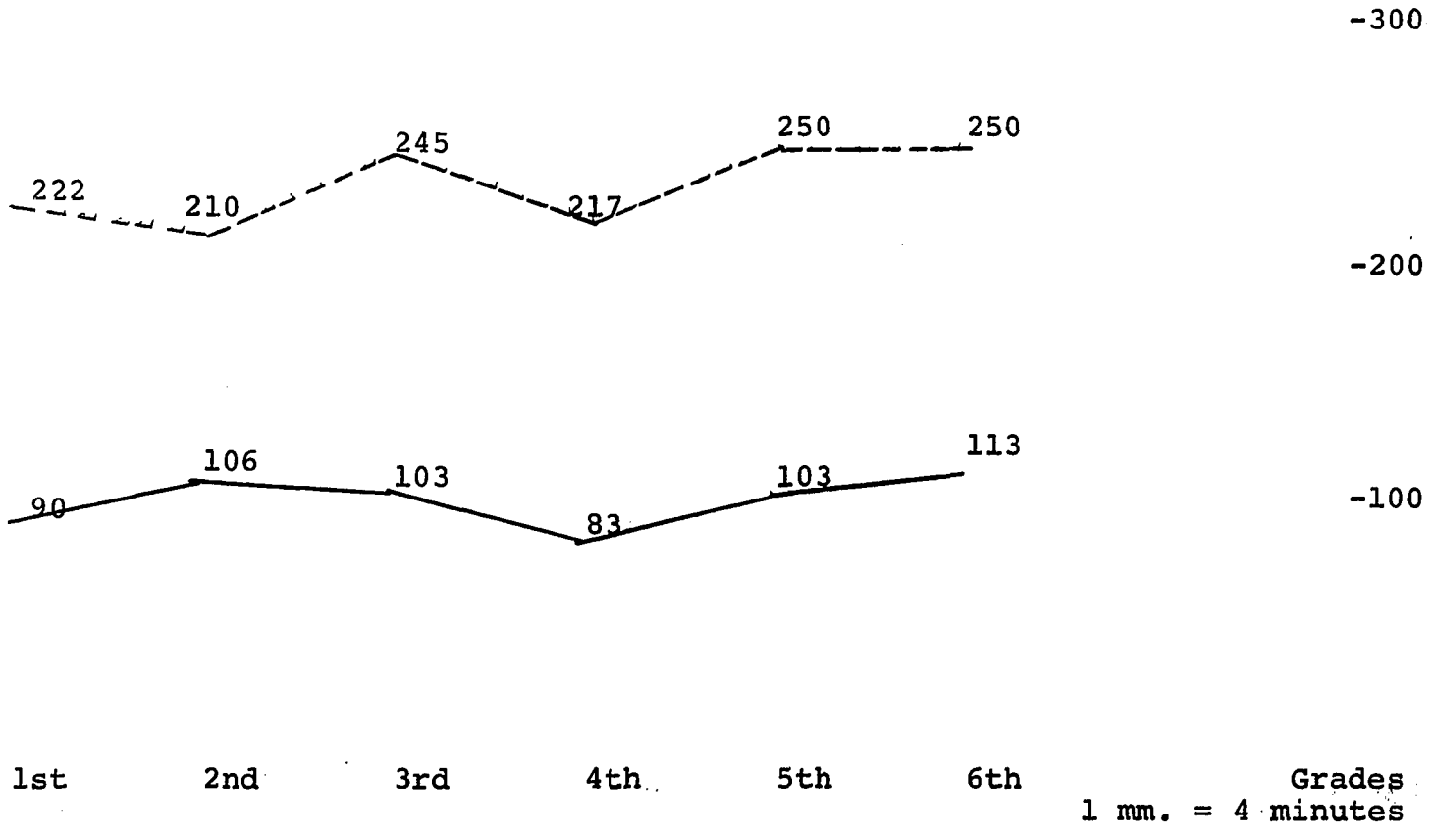


GRAPH 9

Comparing Textbook-Centered and Inquiry-Centered Teachers by Average Time in Minutes/Week/Grade in Arithmetic

_____ = Textbook-Centered

----- = Inquiry-Centered

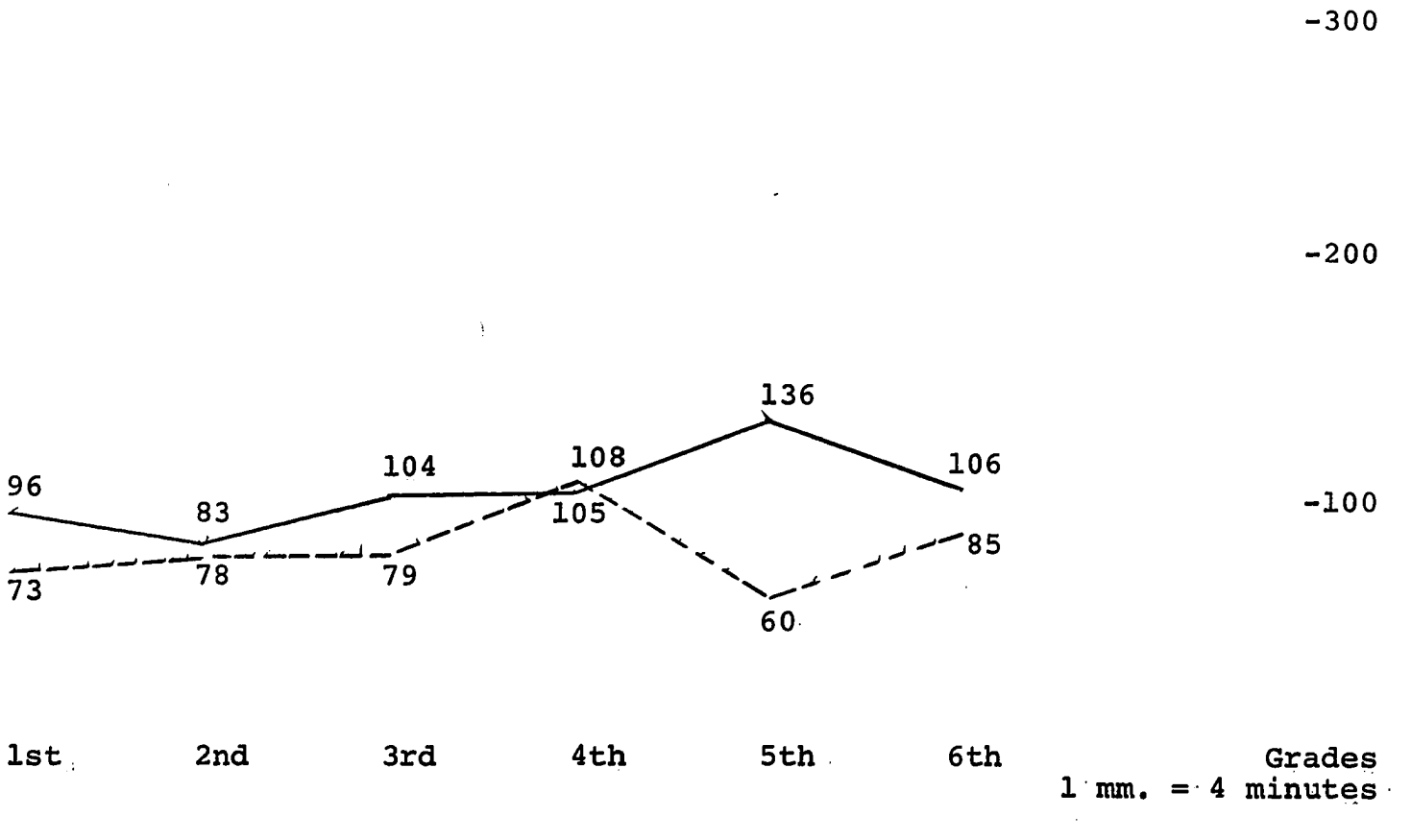


GRAPH 10

Comparing Textbook-Centered and Inquiry-Centered Teachers by Average Time in Minutes/Week/Grade in Music

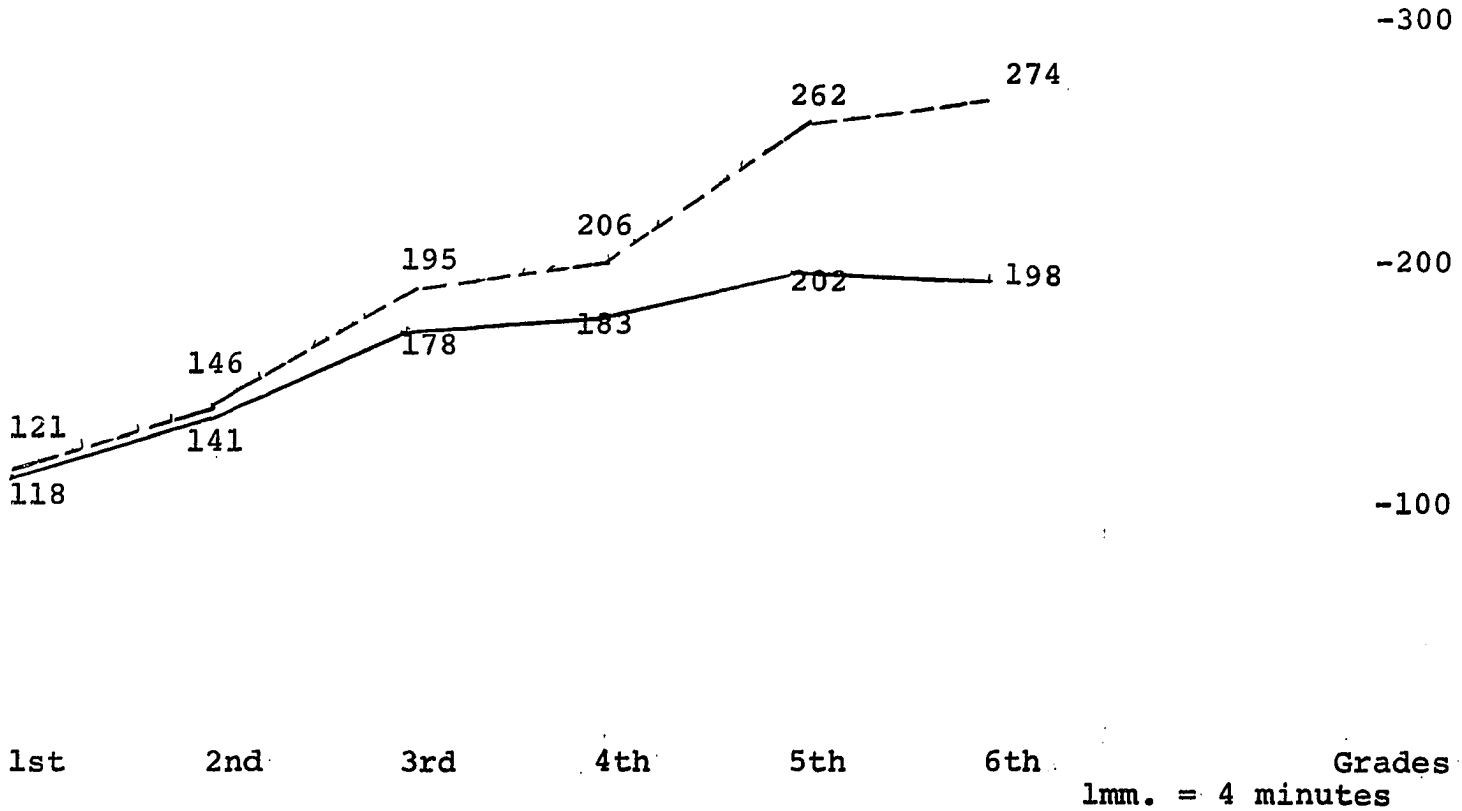
_____ = Textbook-Centered

----- = Inquiry-Centered



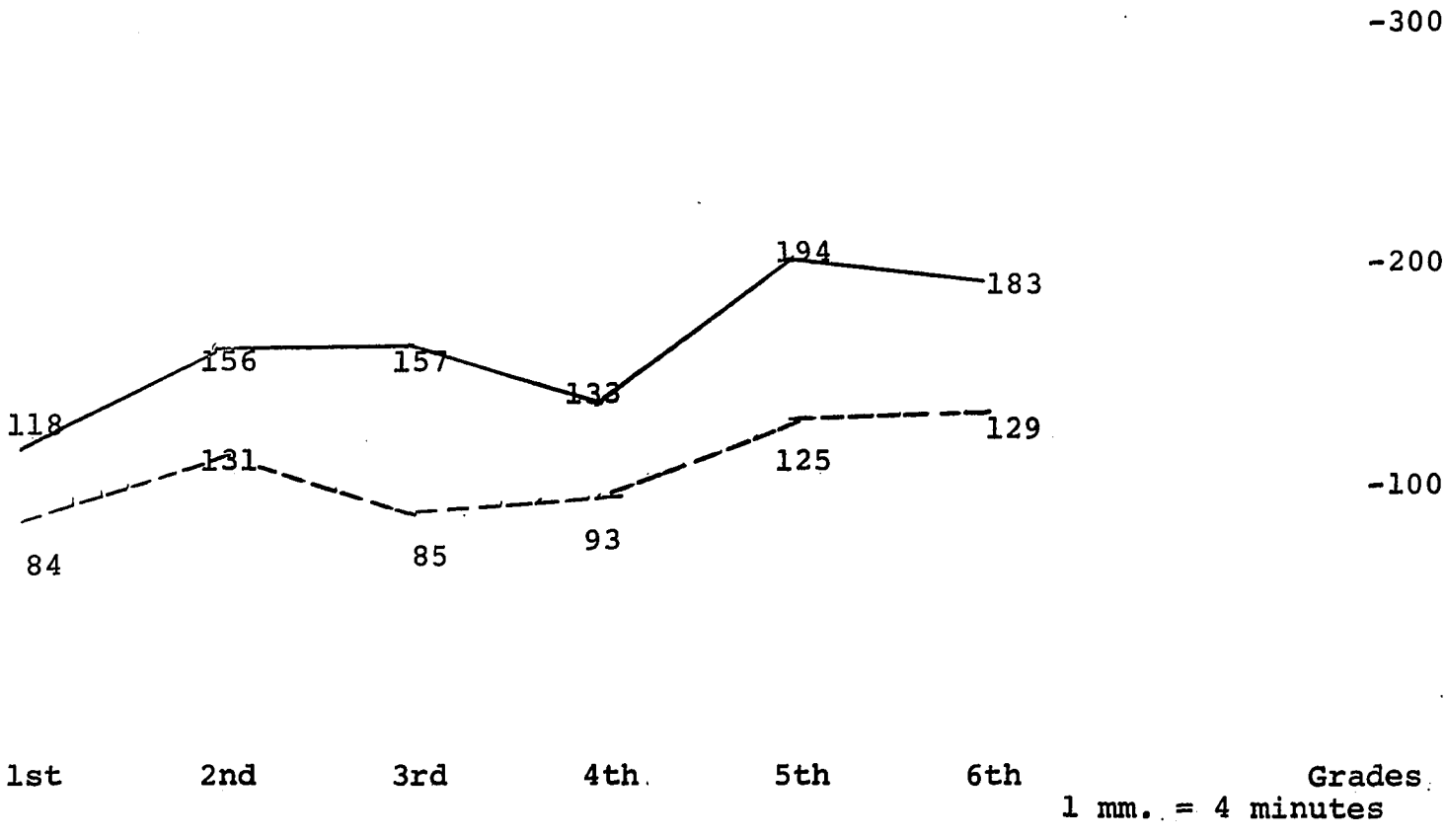
GRAPH 11

Comparing Textbook-Centered and Inquiry-Centered Teachers
by Average Time in Minutes/Week/Grade in Science
_____ = Textbook-Centered
----- = Inquiry-Centered



GRAPH 12

Comparing Textbook-Centered and Inquiry-Centered Teachers
by Average Time in Minutes/Week/Grade in Physical Education
_____ = Textbook-Centered
----- = Inquiry-Centered



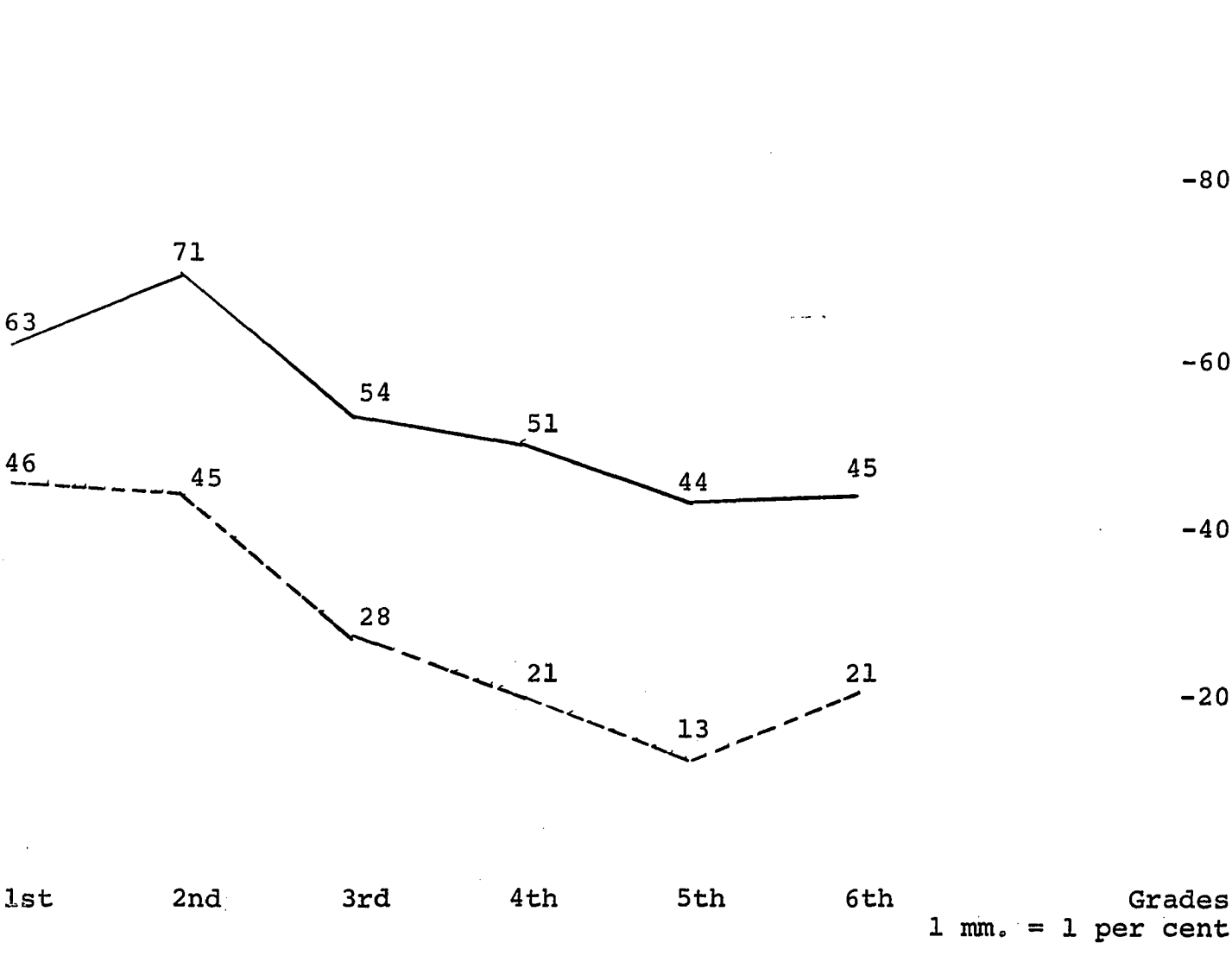
17 per cent, second 26 per cent, third 26 per cent, fourth 30 per cent, fifth 31 per cent, and sixth 24 per cent. These data appear to indicate that the textbook-centered teachers are obstructing the desired progress of pupils to achieve the established objectives of elementary school science by depriving them of the opportunity to learn by direct contact, observation, and manipulation of equipment which would be provided by allowing the pupils to perform demonstrations. The inquiry-centered teachers, by doing fewer demonstrations themselves, are assisting the pupils to progress along the established objectives, in allowing them to perform demonstrations themselves.

Per Cent of Science Class Time Spent By Children Doing Experiments

The two groups of teachers were compared with regard to the percentage of science class time spent by children doing experiments. The data in Graph 14, show that the inquiry-centered teachers in each grade are providing the children with greater opportunities to perform experiments than are the textbook-centered teachers. The grades with the per cent increases of the inquiry-centered over the textbook-centered teachers are as follows: first 48 per cent, second 76 per cent, third 61 per cent, fourth 59 per cent, fifth 52 per cent, and sixth 57 per cent. This comparison seems to indicate that the inquiry-centered teachers have a clear understanding of the methods that are

GRAPH 13

Per cent of Demonstrations Performed by Teachers
_____ = Textbook-Centered Teachers
----- = Inquiry-Centered Teachers

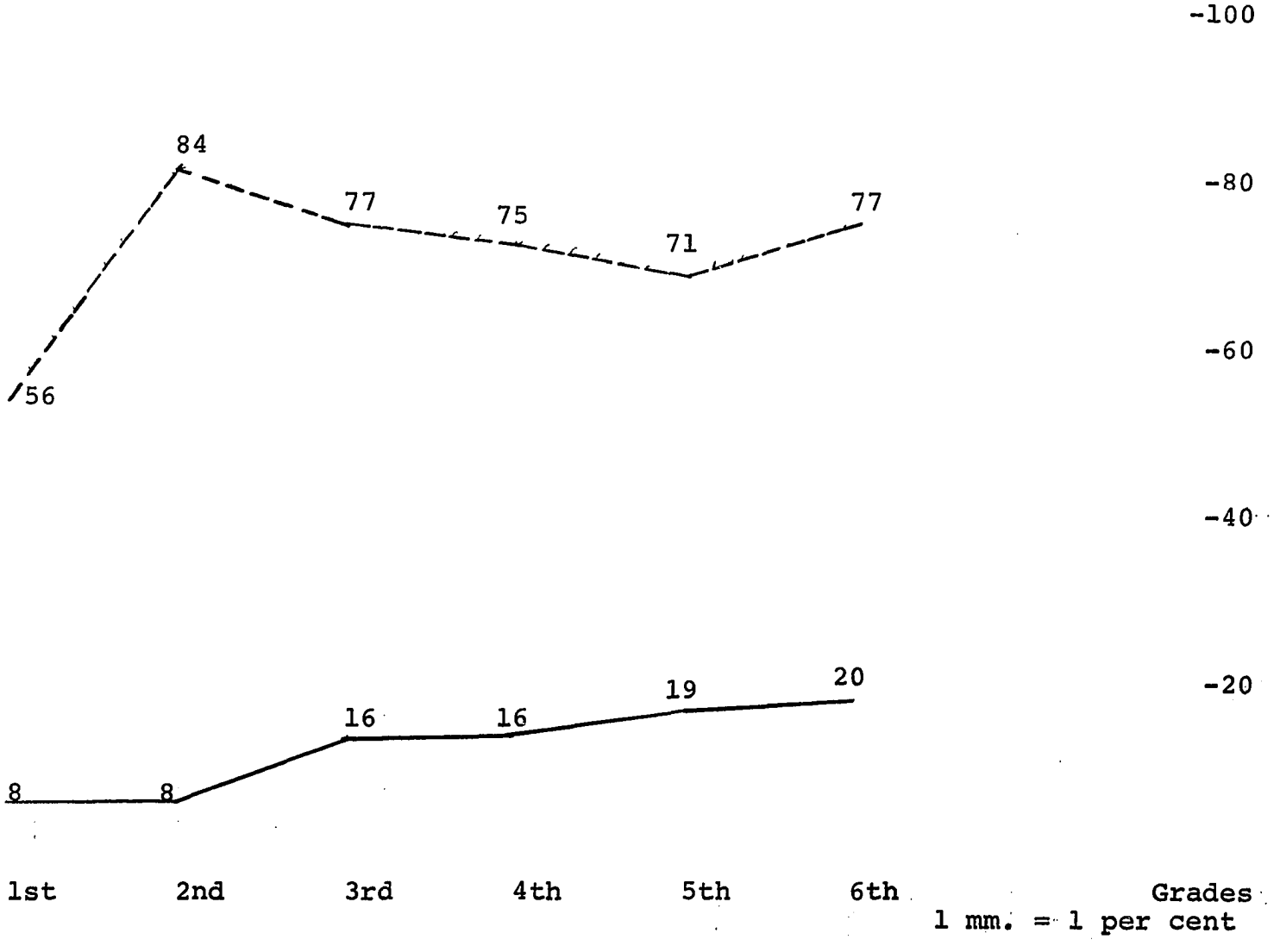


GRAPH 14

Per Cent of Science Class Time Spent by Children Doing Experiments

_____ = Under Textbook-Centered Teacher Direction

----- = Under Inquiry-Centered Teacher Direction



most suitable to the accomplishment of the elementary school science objectives. The inquiry-centered teachers by providing the pupils with an opportunity to perform experiments themselves, are providing them one of the five essential learning experiences as stated by Renner and Ragan in Chapter I of this study.

Summary

Both groups of teachers show a gradual decrease in the amount of time spent in reading and writing from the first through the sixth grades. In four other subject areas (i.e., arts and crafts, arithmetic, music, and physical education) there was some time increase for each. The greatest increase of time was shown in the area of social studies and science. The inquiry-centered teachers, showing more time spent on science than the textbook-centered teachers, appear to indicate that they attach much more importance to the teaching of elementary school science than do the textbook-centered teachers.

The children under the direction of the inquiry-centered teachers, in all six grades, spend more time performing science demonstrations than those under the direction of the textbook-centered teachers. The same relationship is true in regard to children doing experiments. The data of this chapter appear to reinforce the advocates of the inquiry-centered projects, which emphasize the importance

of the pupils themselves performing demonstrations. One of the main goals of the "new" approaches to teaching elementary school science is to allow the pupils to come in direct contact with and manipulate materials and objects. There appears little doubt that the children under the guidance of the inquiry-centered group are being provided greater opportunities to become actively involved in science than those children who are studying science from a textbook.

CHAPTER V

CLASSROOM MANAGEMENT AND AIDS

The opinions of the textbook-centered teachers and the inquiry-centured teachers in regard to the procedures they follow and the type of classroom aids they employ in teaching elementary school science were also collected and studied. That study should serve to indicate the sincerity of teachers in regard to teaching science since it is believed by experts; i.e., Karplus, Their and Renner, in the teaching of elementary school science that the adoption of procedures which will provide the pupils with the opportunities to study the five essential learning experiences is of great importance.

Classroom Management

The classroom management category was subdivided into the areas of time, content source, teacher problems, handling science materials, pupil response, and evaluation.

By analysis of the data in Table 10 dealing with classroom management, in only three of the twenty-three categories was there an indication of no statistical significant difference between the two groups of teachers.

These categories were: the availability of science films, the availability of filmstrips, and the ability to control class size suitable for teaching science. Both groups expressed opinions of dissatisfaction with those categories.

Analysis of the data in Table 10 indicate significant difference between the two groups of teachers in the following subdivisions of classroom management:

1. Time

For the subdivision (1) time regarding (a) allotted time to teach science and (b) the per cent of time spent on science relative to that spent on other aspects of the elementary program, both favor the inquiry-centered teachers over the textbook-centered teachers; the former by 33 per cent and the latter by 38 per cent. This appears to indicate that the inquiry-centered teachers are better satisfied with the amount of time available to them for science. It may be that the type of program they are following in the teaching of elementary science is providing the amount of time they feel is necessary for the program.

2. Content Source

In regard to (2) content source, and (a) use of textbooks by pupils, the textbook-centered teachers are better satisfied than the inquiry-centered teachers by 20 per cent. This is to be expected since the textbook teachers are textbook oriented; (b) use of workbooks by

TABLE 10

COMPARISON OF CLASSROOM MANAGEMENT FOR TEXTBOOK-CENTERED AND INQUIRY-CENTERED TEACHERS

	Textbook-Centered Teachers		Inquiry-Centered Teachers		
	Per Cent		Per Cent		
	Satisfied	Not Satisfied	Satisfied	Not Satisfied	t
1. Time					
(a) Allotted time to teach science	50	50	83	17	4.874*
(b) Per cent of time spent in science relative to that spent on other aspects of the elementary program	45	55	83	17	5.621*
2. Content Source					
(a) Use of text-book by pupils	54	46	34	66	2.460*
(b) Use of work-book by pupils	18	82	39	61	2.609*
(c) The procedure for selecting science content	43	57	86	14	6.750*
(d) Availability of science films	34	66	34	66	0.000
(e) Availability of filmstrips	37	63	34	66	0.371
3. Teacher Problems					
(a) Dividing pupils according to ability or interest	23	77	80	20	8.309*

TABLE 10--Continued

	Textbook-Centered Teachers		Inquiry-Centered Teachers		
	Per Cent		Per cent		
	Satisfied	Not Satisfied	Satisfied	Not Satisfied	t
(b) Handling science problems pupils introduce in class	43	57	88	12	7.401*
(c) Keeping science on proper grade level	71	29	90	10	3.398*
(d) Following a prescribed course of study	59	41	93	7	6.551*
(e) Integrating science with other subjects	56	44	76	24	2.677*
(f) Selecting proper units based on immediate needs	44	56	76	24	4.283*
(g) Relating science to the world of the pupils	60	40	81	19	3.017*
(h) Ability to control class size suitable for teaching science	39	61	46	54	0.828
4. Handling Science Materials					

TABLE 10--Continued

	Textbook-Centered Teachers		Inquiry-Centered Teachers		
	Per Cent		Per Cent		
	Satisfied	Not Satisfied	Satisfied	Not Satisfied	t
(a) Arranging science displays and pupil collections	36	64	61	39	3.019*
(b) Performing science experiments	19	81	100	0	30.566*
(c) Performing science demonstrations	22	78	95	5	16.553*
(d) Pupils' ability to devise own apparatus	20	80	64	36	5.144*
5. Pupil Response					
(a) Interest displayed by pupils in the classroom	68	32	95	5	5.819*
(b) Assisting pupils to discover facts for themselves	45	55	90	10	7.799*
(c) Developing pupils' ability to make accurate observations and to draw valid conclusions	34	66	86	14	8.267*
6. Evaluation					
(a) Evaluating pupils' progress in science	34	66	61	39	3.268*

*Significant at the 0.05 level

pupils, the inquiry-centered teachers are more satisfied than the textbook teachers by 21 per cent. The types of workbooks or direction manuals used by the two groups of teachers are different. This suggests that the manuals used by the inquiry-centered teachers are better coordinated with their program in science, than are the ones used by the textbook-centered teachers, and (c) the procedure for selecting science content was in favor of the inquiry-centered teachers by 43 per cent. This tends to support the finding regarding freedom for selecting science content as established in Chapter II of this study. The inquiry-centered teachers seem to be better satisfied with both procedure and freedom in the selection of science content than are the textbook-centered teachers.

Regarding (d) availability of science films, and (e) availability of filmstrips, there was no statistical significant difference between the two groups of teachers. Both indicated dissatisfaction with these two items.

3. Teacher Problem

Examining (3) teacher problems, (a) dividing pupils according to ability or interest was in favor of the inquiry-centered group by 57 per cent, (b) handling science problems pupils introduce in class favored the inquiry-centered teachers by 45 per cent, and (c) keeping science on proper grade level favored the inquiry-centered teachers by 19 per

cent, (d) following a prescribed course of study favored the inquiry-centered teachers by 34 per cent, (e) integrating science with other subjects favored the inquiry-centered teachers by 20 per cent, (f) selecting proper units based on immediate needs was in favor of the inquiry group by 33 per cent, and (g) relating science to the world of the pupils favored the inquiry-centered teachers by 21 per cent. These seven categories appear to indicate that the inquiry-centered teachers have had education which enables them to handle problems as they arise in the teaching procedures of elementary school science, to the advantage of the pupils.

Regarding the last category (h) ability to control class size suitable for teaching science; there was no statistical significant difference between the two groups of teachers. Both indicated dissatisfaction with this category.

4. Handling Science Materials

In regard to (4) handling science materials, (a) arranging science displays and pupil collections favored the inquiry-centered teachers by 25 per cent, (b) performing science experiments favored the inquiry-centered teachers by 81 per cent, (c) performing science demonstrations favored the inquiry-centered teachers by 73 per cent, and (d) pupils' ability to devise own apparatus favored the inquiry-centered teachers by 44 per cent. These opinions

as expressed by the inquiry-centered teachers in regard to handling science materials seem to verify the ability they have acquired in their education--to make available to the pupils the opportunities to manipulate science materials which is an important object of the "new" methods of teaching elementary school science. It indicates the importance that the inquiry-centered teachers place upon classifying and organizing science materials, performing science experiments and demonstrations, and the ability of the pupils to devise their own apparatus. All of these procedures provide excellent learning situations for elementary pupils; learning situations that seem to be lacking in the science programs of the textbook-centered teachers.

5. Pupil Response

The investigator believes that (5) pupil response denotes one of the most important findings in this study. The data reveal the following information: (a) interest displayed by pupils in the classroom favored the inquiry-centered teachers by 27 per cent. This appears to point out the effectiveness of the inquiry-centered teachers over the textbook-centered teachers in motivating pupils to become involved in elementary school science. (b) Assisting pupils to discover facts for themselves favored, again, the inquiry-centered teachers by 45 per cent. This seems to support the contention that the inquiry-centered

teachers are teaching the pupils to learn by the inquiry method rather than providing them with answers to be committed to memory, and (c) developing pupils' ability to make accurate observations and to draw valid conclusions favored the inquiry-centered teachers by 52 per cent. This points out the importance that the inquiry-centered teachers attach to teaching pupils to learn the techniques of observation and drawing valid conclusions.

6. Evaluation

Concerning (6) evaluation, (a) evaluating pupils' progress in science favored the inquiry-centered teachers by 27 per cent. This suggests that the inquiry-centered teachers have had education which has provided them with techniques to properly evaluate the progress of elementary science pupils. It seems further to suggest that they have a better understanding of how to evaluate the objectives of elementary school science than the textbook-centered teachers.

Classroom Aids

In regard to classroom aids, it was determined to subdivide them into the following areas: (1) materials and apparatus, and (2) aids to classroom procedures.

1. Materials and Apparatus

By analysis of Table 11 in the subdivision (1) materials and apparatus, two items showed no statistical

difference; these were: (g) ability to provide free materials and (f) ability to provide for living things in the classroom. Both groups of teachers indicated dissatisfaction with these items.

In items (c) availability of storage space for science materials, and (d) availability of bulletin boards, aquaria, cages, etc., both groups indicate dissatisfaction. However, the textbook-centered teachers indicate a higher degree of dissatisfaction than do the inquiry-centered teachers.

The following items: (a) availability of funds for classroom science materials, (b) availability of science apparatus (i.e., batteries, balances, glassware, etc.), and (e) ability to improvise equipment all favor the inquiry-centered teachers over the textbook-centered teachers. It appears that the inquiry-centered teachers have had education which has emphasized the need for these materials in carrying out an efficient elementary science program.

2. Aids to Classroom Procedures

By analysis of Table 11 in the subdivision (2) aids to classroom procedures, two items (b) ability to provide local natural areas to supplement classroom discussions and (c) opportunity for field trips showed no statistical significant difference.

The remaining six items (a) availability of qualified science advisory personnel, (d) securing administrative

approval for excursions, (e) securing parental approval for excursions, (f) securing funds for excursions, (g) arranging classes for excursions, and (h) providing for pupils' safety on excursions, all favored the inquiry-centered teachers over the textbook-centered teachers. These data, again, suggest that the inquiry-centered teachers have had education which has pointed out to them the value of these items in the culmination of the elementary science program. These items in favor of the inquiry-centered teachers seems to re-emphasize the importance which they attach to making available aids outside the classroom which may provide valuable learning experiences.

Summary

In these areas of classroom management: time, content source, teacher problems, handling science materials, pupil response and evaluation the inquiry-centered teachers appear to be better qualified to cope with the problems as they are presented in the various areas than are the textbook-centered teachers. Also, the inquiry-centered teachers display more confidence than the textbook-centered teachers in performing experiments, demonstrations, and teaching by the discovery method. At the same time, they have more confidence in directing the pupils in the building of apparatus, relating science to their environment, making accurate observations, drawing valid conclusions, and becoming more motivated toward the study of science.

TABLE 11

COMPARISON OF CLASSROOM AIDS FOR TEXTBOOK-CENTERED AND INQUIRY-CENTERED TEACHERS

	Textbook-Centered Teachers		Inquiry-Centered Teachers		
	Per Cent		Per Cent		
	Satisfied	Not Satisfied	Satisfied	Not Satisfied	t
1. Materials and Apparatus					
(a) Availability of funds for classroom science materials	24	76	54	46	3.614*
(b) Availability of science apparatus (i.e., batteries, balances, glassware)	22	78	64	36	5.350*
(c) Availability of storage space for science materials	19	81	37	63	2.252*
(d) Availability of bulletin boards aquariums, cages	28	72	49	51	2.506*
(e) Ability to improvise equipment	27	73	68	32	5.203*
(f) Ability to provide for living things in the classroom	30	70	46	54	1.909
(g) Ability to provide free materials	32	68	46	54	1.905
2. Aids to Classroom Procedures					

TABLE 11--Continued

	Textbook-Centered Teachers		Inquiry-Centered Teachers		
	Per Cent		Per Cent		
	Satisfied	Not Satisfied	Satisfied	Not Satisfied	t
(a) Availability of qualified science advisory personnel	22	78	86	14	10.492*
(b) Ability to provide local natural areas to supplement classroom discussions	31	69	42	58	1.322
(c) Opportunity for field trips	34	66	42	58	0.958
(d) Securing administrative approval for excursions	55	45	76	24	2.822*
(e) Securing parental approval for excursions	66	34	98	2	8.247*
(f) Securing funds for excursions	22	78	51	49	3.498*
(g) Arranging classes for excursions	44	56	66	34	2.706*
(h) Providing for pupils' safety on excursions	53	47	71	29	2.293*

*Significant at the 0.05 level

The inquiry-centered teachers are more satisfied with the availability of materials and apparatus probably due to a better understanding of the types and kinds of materials and apparatus desirable for teaching elementary school science. They, also, appear to be better satisfied with the availability of qualified science advisory personnel and their own ability to provide learning experiences outside the classroom through field trips and excursions.

CHAPTER VI

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of this research study was to determine whether or not there was a significant difference in the opinions of teachers who had received education in the inquiry method of teaching and those teachers who had received education which was textbook oriented in regard to teaching elementary school science.

From an analysis of the data collected from the questionnaires, the following significant information was determined:

1. There is a noticeable similarity between the two groups of teachers (i.e., textbook-centered and inquiry-centered) in respect to teaching experience in the elementary grades, participation in teaching elementary science and, also, their educational backgrounds. However, the two groups show a significant difference in regard to their having profited by the different types of teaching methods courses. The satisfaction with the methods courses favored the inquiry-centered teachers.

2. The inquiry-centered teachers are twice as satisfied with the selection of elementary school science content, as the textbook-centered teachers. The textbook-centered teachers are lacking in physical and library facilities and their science program suggests that it is subject-matter centered; while the inquiry-centered teachers' program is process and subject-matter centered.

3. The inquiry-centered teachers spend more time on science than the textbook-centered teachers. This may be interpreted to mean that they attach much more importance to the teaching of elementary school science than do the textbook-centered teachers.

The children, in all six grades, are allowed to spend more time performing science demonstrations and experiments under the supervision of the inquiry-centered group than those under the supervision of the textbook-centered teachers.

4. The inquiry-centered teachers are better satisfied with the problems involved in classroom management (i.e., time, content source, teacher problems, handling science materials, pupil response, and evaluation) than are the textbook-centered teachers. The inquiry group also displays more confidence in handling demonstrations and experiments and teaching by the inquiry method. The inquiry-centered teachers are better satisfied than are the textbook-centered teachers with the available materials

and apparatus, qualified advisory personnel and providing for teaching areas outside the classroom.

Conclusions

Based on the data collected, the following conclusions were drawn:

1. The inquiry type of methods courses are better oriented toward educating teachers in obtaining a wholesome attitude toward science teaching and increasing the teachers' interest in science.

2. The inquiry-centered teachers have had education which has guided them in the selection of science content which is directed toward the achievement of elementary science objectives.

3. The inquiry-centered teachers are better equipped with physical and library facilities which enhance the elementary science program than are the textbook-centered teachers.

4. The science program of the inquiry-centered teachers is both process and subject-matter centered; whereas the textbook-centered teachers' program is subject-matter centered only.

5. The inquiry-centered teachers spend more time on science; this fact indicates that they have more interest in science teaching than the textbook-centered group.

6. By allowing the pupils to spend more time performing demonstrations and experiments, the inquiry-centered

group are providing them with the opportunity to have the five essential learning experiences.

7. The inquiry-centered teachers are better qualified to cope with the problems involved in classroom management and the necessary aids to classroom procedures for teaching elementary school science.

Recommendations

Based on the conclusions drawn from this study, the following recommendations are made:

1. Colleges and universities should include a methods course based on the inquiry process in their educational program for elementary school science teachers. Such a course would provide the teacher with the necessary experience to teach elementary school science in a manner conducive to the accomplishment of the elementary school science objectives which were spelled out in 1968 by the State Department of Education.

2. Elementary school administrators should examine and give serious thought to providing for the introduction of one of the "newer" science curriculum development programs in their elementary schools; these programs have proven to be superior to conventional programs in developing pupils' rational powers.

3. Elementary teachers already in the field should be encouraged to attend one of the summer institutes which

focus upon the inquiry process for educating elementary school science teachers.

4. During the regular school sessions, elementary science teachers should be supplied the assistance of qualified advisory personnel.

5. An evaluative instrument should be developed for the "newer" programs. This is needed to determine the value of these "newer" programs in regard to the knowledge gained by having had the five essential learning experiences which have been stated in this study.

6. A study, similar to this study, which would include a larger sample of the inquiry-centered teachers (now possible from the additional SCIS centers that are now in operation) should prove of value.

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APPENDIX A

COVERING LETTER

Dear Classroom Teacher:

Although there are numerous demands on your time, will you take a few minutes for a task which may have significance in the improvement of teaching positions such as yours?

The information obtained from the questionnaire may terminate in valuable data leading to the improvement of working conditions of elementary teachers of science in Oklahoma.

You are being sent this questionnaire as one of a select group, whose personal judgment is considered important to this study.

Will you cooperate in this study by completing the attached questionnaire at your earliest convenience and return it in the self-addressed stamped envelope.

No teacher, school or school system will be identified in the results of this study.

Sincerely yours,

L. E. Wallen
Northeastern State College
Tahlequah, Oklahoma

COVERING LETTER

Dear Classroom Teacher:

Will you take a few minutes for a task which may have significance in the improvement of teaching positions such as yours?

This study is being carried out by Dr. John Renner of the University of Oklahoma and myself.

Please answer the questionnaire upon the basis of a comparison of the type of program you are pursuing now and the previous traditional textbook approach.

The information obtained from the questionnaire may terminate in valuable data leading to the improvement of working conditions of elementary teachers of science in Oklahoma.

No teacher, school or school system will be identified in the results of this study.

Sincerely yours,

L. E. Wallen
Northeastern State College
Tahlequah, Oklahoma

APPENDIX B

A. CIRCLE THE LETTER ON THE RIGHT WHICH BEST REPRESENTS YOUR JUDGMENT OF THE STATEMENT ON THE LEFT AS IT APPLIES TO YOUR SCHOOL AND CLASSROOM:

I. Classroom Management	Satisfied	Not Satisfied	Distinctly Dissatisfied
1. Allotted time to teach science	A	B	C
2. Handling science problems pupils introduce in class	A	B	C
3. Keeping science on proper grade level	A	B	C
4. Integrating science with other subjects	A	B	C
5. Following a prescribed course of study	A	B	C
6. Selecting proper units based on immediate needs	A	B	C
7. Interest displayed by pupils in the classroom	A	B	C
8. Use of textbook by pupils	A	B	C
9. Use of workbook by pupils	A	B	C
10. Availability of science films	A	B	C
11. Availability of filmstrips	A	B	C

Classroom Management	Satisfied	Not Satisfied	Distinctly Dissatisfied
12. Performing science experiments	A	B	C
13. Performing science demonstrations	A	B	C
14. Pupils ability to devise own apparatus	A	B	C
15. Dividing pupils according to interest or ability	A	B	C
16. Per cent of time spent on science relative to that spent on other aspects of the elementary program	A	B	C
17. The procedure for selecting science content	A	B	C
18. Assisting pupils to discover facts for themselves	A	B	C
19. Arranging science displays and pupil collections	A	B	C
20. Relating science to the world of the pupils	A	B	C
21. Developing pupils ability to make accurate observations and to draw valid conclusions	A	B	C
22. Evaluating pupils progress in science	A	B	C

Classroom Management	Satisfied	Not Satisfied	Distinctly Dissatisfied
23. Ability to control class size suitable for science	A	B	C
24. Other _____ _____ _____	A	B	C
II. Content, Subject Matter, Area of Experience			
1. Opportunity to improve science background	A	B	C
2. Ability to obtain non-technical materials	A	B	C
3. Ability to obtain information on science workshops, in-service offerings, and short courses	A	B	C
4. Ability to adapt technical materials to the level of pupils	A	B	C
5. Freedom to select science content taught	A	B	C
6. Other _____ _____ _____	A	B	C
III. Classroom Aids			
1. Availability of funds for classroom science materials	A	B	C
2. Availability of science apparatus (i.e., batteries, balances, glassware, etc.)	A	B	C

Classroom Aids	Satisfied	Not Satisfied	Distinctly Dissatisfied
3. Availability of storage space for science materials	A	B	C
4. Availability of bulletin boards, aquariums, cages, etc.	A	B	C
5. Availability of qualified science advisory personnel	A	B	C
6. Ability to improvise equipment	A	B	C
7. Ability to provide natural areas to supplement classroom discussions	A	B	C
8. Ability to provide for living things in classroom	A	B	C
9. Ability to provide free materials	A	B	C
10. Opportunity for field trips	A	B	C
11. Securing administrative approval for excursions	A	B	C
12. Securing parental approval for excursions	A	B	C
13. Securing funds for excursions	A	B	C
14. Arranging classes for excursions	A	B	C
15. Providing for pupil safety on excursions	A	B	C
16. Other _____ _____ _____	A	B	C

IV. Physical Facilities	Satisfied	Not Satisfied	Distinctly Dissatisfied
1. Size of classroom for science	A	B	C
2. Shelving for science materials	A	B	C
3. Availability of electrical outlets	A	B	C
4. Availability of water for experiments	A	B	C
5. Availability of worktables	A	B	C
6. Availability of heat for experiments	A	B	C
7. Availability of preparation room or table for science materials	A	B	C
8. Other _____ _____ _____	A	B	C
V. Library Facilities			
1. Availability of reference material	A	B	C
2. Availability of supplementary science books of the desired grade level	A	B	C
3. Ability to evaluate elementary science textbooks and workbooks	A	B	C
4. Availability of funds for elementary library materials	A	B	C
5. Provisions for obtaining materials from library for classroom use	A	B	C

Library Facilities	Satisfied	Not Satisfied	Distinctly Dissatisfied
6. Other _____ _____ _____	A	B	C

VI. College Preparation (React to the Following Statements from your own Experience in College)

1. College science subject matter courses	A	B	C
2. Quantity of laboratory science courses	A	B	C
3. College methods courses in science	A	B	C
4. Adequate coverage of biological sciences	A	B	C
5. Adequate coverage of physical sciences	A	B	C
6. Motivation toward a wholesome attitude for science teaching	A	B	C
7. Other _____ _____ _____	A	B	C

B. General Information

1. Circle the Grade or Grades you are Presently Teaching and List the Enrollment

   a. First Grade _____ Enrollment _____
   b. Second Grade _____ Enrollment _____
   c. Third Grade _____ Enrollment _____
   d. Fourth Grade _____ Enrollment _____
   e. Fifth Grade _____ Enrollment _____
   f. Sixth Grade _____ Enrollment _____

2. Indicate the Number of Years you have Taught in the Elementary Grades

   _____

3. Indicate the Number of Years you have Taught Elementary Science

_____

4. How is the Science Content for the Elementary Program Selected

a. School Superintendent _____
b. Committee _____
c. Grade Teacher _____
d. Elementary Principal _____
e. Other _____

5. List the Title and Publisher of the Elementary Textbook you are Using

_____

List the Population of the Community in which you are Teaching or Name the Community

_____

6. Estimate the Time in Minutes Per Week you Spend in Class on Each of the Following Subjects

a. Reading _____
b. Writing _____
c. Social Studies _____
d. Arts and Crafts _____
e. Arithmetic _____
f. Music _____
g. Science _____
h. Physical Education _____

7. Indicate the Per Cent of the Demonstrations which are Performed by

a. children _____ b. teacher _____

8. Indicate the Percentage of Science Class Time which is Devoted to the Children doing the Experiments _____

C. Educational Information

B.A. or B.S. _____ Major _____ Minor _____ Date _____

Where Granted _____

M. A. or M.S. _____ Major _____ Minor _____ Date _____

Where Granted _____

Ph.D. or Ed.D _____ Major _____ Minor _____ Date _____

Where Granted _____