The Teachers' and Principals' Perceptions of the Impact of Operation Physics on the Teaching of Elementary Science in Michigan Schools

Brenda Prater Earhart

Western Michigan University

Follow this and additional works at: https://scholarworks.wmich.edu/dissertations

Part of the Educational Methods Commons, and the Science and Mathematics Education Commons

Recommended Citation
https://scholarworks.wmich.edu/dissertations/1766

This Dissertation-Open Access is brought to you for free and open access by the Graduate College at ScholarWorks at WMU. It has been accepted for inclusion in Dissertations by an authorized administrator of ScholarWorks at WMU. For more information, please contact maira.bundza@wmich.edu.
THE TEACHERS' AND PRINCIPALS' PERCEPTIONS OF THE IMPACT OF OPERATION PHYSICS ON THE TEACHING OF ELEMENTARY SCIENCE IN MICHIGAN SCHOOLS

by

Brenda Prater Earhart

A Dissertation
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
Degree of Doctor of Education
Department of Educational Leadership

Western Michigan University
Kalamazoo, Michigan
June 1995
THE TEACHERS' AND PRINCIPALS' PERCEPTIONS OF THE IMPACT OF OPERATION PHYSICS ON THE TEACHING OF ELEMENTARY SCIENCE IN MICHIGAN SCHOOLS

Brenda Prater Earhart, Ed.D.
Western Michigan University, 1995

The purpose of this study was to determine the impact of Michigan Operation Physics (MOP) on the teaching and learning of basic physics concepts in the elementary classroom as perceived by both the teachers and principals of those teachers. In addition, the study sought to identify the teachers' and principals' perceptions of the principal's role in promoting science at the elementary level.

The method used for this study was survey research. Questionnaires were mailed to Michigan Operation Physics participants, non-Michigan Operation Physics participants, and the principals of those teachers in southwestern Michigan.

Findings of this study were that teachers' and principals' perceptions of the impact of Michigan Operation Physics on the teaching of elementary science were positive. Teachers (82.4%) perceived their attitudes toward science and the teaching of science were more positive due to participation in Michigan Operation Physics. Michigan Operation Physics participants (97.3%) revealed hands-on, inquiry based science instruction was modeled as a teaching strategy. Findings of this study indicate that 85.7% of MOP participants are "confident" or "moderately comfortable" with physical science concepts. This compares favorably
to the same perception held by 72.8% of principals.

Principals perceived they demonstrate leadership in elementary science by discussing science with their teachers, visiting classrooms when science lessons are being taught, and insisting that science is taught a specified amount of time. The study revealed that 90.9% of principals felt science should be taught everyday for a period of 20 to 40 minutes. Over 80% of principals indicated local funds were provided for the support of school science. The perceptions held by teachers regarding the principal’s leadership role were not consistent with those of principals.

The limited scope of this study precludes the adoption of any definitive position.
INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.
ACKNOWLEDGMENTS

Special thanks are extended to Dr. Uldis Smidchens, my advisor, for directing and supporting me through the program. I express special appreciation to Dr. Charles Warfield and Dr. Donald Thompson, my committee members, for their patience and constructive criticism.

To my family I owe special thanks: my parents who instilled in me the importance of all educational endeavors; my husband, Malcolm, for his support and patience; my children, Malcolm and Tiombe, for their love; and my sisters and brothers for believing in me.

Deepest appreciation to my "special friend," Terina Walker Harvey, for all the support and encouragement we provided each other.

Brenda Prater Earhart
# TABLE OF CONTENTS

ACKNOWLEDGMENTS ................................................................. ii
LIST OF TABLES ........................................................................ vi

CHAPTER

I. INTRODUCTION ................................................................... 1
   Background ........................................................................ 1
   Statement of the Problem ............................................. 7
   Need and Significance of the Study ......................... 9
   Summary ...................................................................... 10

II. REVIEW OF LITERATURE ................................................. 11
   Introduction ...................................................................... 11
   Postwar Era (1945-1955) .......................................... 12
   The Rise of the National Science Foundation (1955-1970) ......................................................... 12
   The Decline of NSF (1970-1980) ......................... 15
   Dilemma in the In-Service Education of Elementary Science Teachers ............................................ 15
   Elements of Effective In-Service Education ............... 19
   In-Service ...................................................................... 21
   Levels of Impact ............................................................. 22
   Components of Training ................................................. 23
   Michigan Operation Physics: A Science In-Service Education Program .................................................. 26

III. METHODOLOGY ................................................................. 29
   Organization of Methodology .................................... 29
# Table of Contents--Continued

## CHAPTER

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>29</td>
</tr>
<tr>
<td>Sample Selection</td>
<td>30</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>31</td>
</tr>
<tr>
<td>Pilot Test and Data Collection Procedure</td>
<td>34</td>
</tr>
<tr>
<td>Data Analysis Procedure</td>
<td>35</td>
</tr>
<tr>
<td>Summary</td>
<td>38</td>
</tr>
</tbody>
</table>

## IV. ANALYSIS OF DATA

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>39</td>
</tr>
<tr>
<td>Descriptive Statistics and Findings</td>
<td>40</td>
</tr>
<tr>
<td>Research Questions</td>
<td>44</td>
</tr>
<tr>
<td>Perceived Effectiveness of MOP Training</td>
<td>44</td>
</tr>
<tr>
<td>Instructional Strategies</td>
<td>50</td>
</tr>
<tr>
<td>Perceived Conceptual Understanding</td>
<td>58</td>
</tr>
<tr>
<td>Perceived Administrative Support</td>
<td>60</td>
</tr>
<tr>
<td>Summary</td>
<td>65</td>
</tr>
</tbody>
</table>

## V. CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization of the Chapter/Synopsis</td>
<td>68</td>
</tr>
<tr>
<td>Conclusions</td>
<td>70</td>
</tr>
<tr>
<td>Implications of the Study</td>
<td>72</td>
</tr>
<tr>
<td>Recommendations for Further Research</td>
<td>73</td>
</tr>
<tr>
<td>Summary</td>
<td>74</td>
</tr>
</tbody>
</table>

## APPENDICES

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Map of Accessible Population</td>
<td>77</td>
</tr>
</tbody>
</table>

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Table of Contents--Continued

B. Letter of Intent to Operation Physics Team Members ..... 79
C. Letter to Principals Requesting Names of Non-Operation Physics Teachers ........................................... 81
D. Teacher Survey and Cover Letter (Michigan Operation Physics) .............................................................. 83
E. Teacher Survey and Cover Letter (Non-Operation Physics) ....................................................................... 91
F. Principal Survey and Cover Letter ...................................................... 102
G. Letters Requesting Participation in the Pilot Study ........ 109
H. Follow-up Letters to Nonrespondents ................................. 112
I. Approval Letter From Human Subjects Institutional Review Board .......................................................... 115
J. Raw Data .................................................................................... 117

BIBLIOGRAPHY ........................................................................... 121
LIST OF TABLES

1. Distribution of Returns ............................................................... 40
2. General Characteristics of Teachers in Survey ...................... 42
3. Effectiveness of Michigan Operation Physics In-Service .... 45
4. Teachers' Perceptions of Changes Attributed to
   In-Service Experiences .............................................................. 47
5. Perceived Professional Changes ................................................ 49
6. Perceived Impact of MOP In-Services on the Classroom .... 51
7. Mean Ranking of Teaching Strategies Used in Science
   Classes Before MOP In-Service Training ................................. 51
8. Mean Ranking of Teaching Strategies Used in Science
   Classes After MOP In-Service Training ................................... 52
9. Mean Ranking of Teaching Strategies Used in Science
   Classes After Non-MOP Participation in In-Service
   Training ....................................................................................... 54
10. Rank Comparison of Instructional Strategies Used to
    Teach Science as Perceived by Principals and
    Teachers After Participation in MOP ........................................ 55
11. Minutes Spent Per Science Lesson .......................................... 56
12. Percentage of Teachers Observed by Principal
    Teaching Science ........................................................................ 57
13. Mean Rank of Factors Affecting the Teaching of
    Science as Perceived by the Principal .................................. 58
14. Comparison of Principals' and Teachers' Perceptions of
    Teachers' Conceptual Understanding of Physical
    Science Concepts ......................................................................... 60
15. Comparison of Teachers' and Principals' Perceptions of
    How the Principals Demonstrate Leadership in
    Elementary Science .................................................................... 62
16. Teachers' and Principals' Perceptions of How
    Principal Contributes to In-Service ........................................ 63
CHAPTER I

INTRODUCTION

The purpose of this study was to determine the impact of Michigan Operation Physics (MOP), a teacher in-service program in physical science for upper elementary and middle school teachers, on the teaching and learning of basic physics concepts, as perceived by both the teachers and the principals of those teachers who have participated in Michigan Operation Physics. While the study deals directly with one specific in-service program in elementary science, the researcher is aware that in the state of Michigan there are numerous efforts to bring about a reform of the teaching of science in the elementary classroom. The study deals with the perceptions of teachers and principals involved with Michigan Operation Physics; it also seeks to answer some related questions as well as point out some trends which are linked, at least in the mind of the researcher, to the potential impact of science in-service in the elementary classroom.

Background

Elementary school science, "a vanishing species" (Rowe, 1980, p. 19), "not basic" (Simpson, 1983, p. 68), and "textbook driven" (Yager & Penick, 1983, p. 68) are expressions representing the feelings of many people, including science educators, regarding the status of elementary science in the United States today. Mechling and Oliver
(1983) viewed children as naturally interested in science. The current climate is exciting as people enter a new frontier of science education despite the many "indicators of crisis" (Yager & Penick, 1983, p. 68).

Despite the reports of successes in science education, some problems are more pronounced than ever before. In 1957 with the launching of Sputnik in the Soviet Union, the United States was empowered to place precollege science education as a top priority. The period from 1955 to 1974 "unparalleled in the degree of activity in science education" (Helgeson, Blosser, & Howe, 1978, p. 13) has been described by Gerlovich and Downs (1980) as the "Golden Age" (p. 651) of science education. Millions of dollars were spent to develop hands-on materials and train teachers to reflect the new interest and direction of science education. So, why is science education in a crisis in the late 20th century?

During the golden age, the National Science Foundation (NSF) "stimulated school science curriculum development to a stage it may not achieve again" (Orlich, 1980, p. 67). An era of disillusionment was brought on by economic restraint in the early 1970s. School science struggled with a shortage of science teachers, an increasingly negative public image due to the role of technology in the Viet Nam conflict, and the termination of funding (Yager & Penick, 1983).

In 1977 three major National Science Foundation (NSF) research efforts were launched to determine the impact of the newly developed hands-on science curricula and the National Science Foundation (NSF) institutes (science in-service) for elementary teachers. Despite the tremendous efforts of NSF and others, findings showed at the
elementary level, only 30% of the nation's schools have ever used the curricula and only 7% of teachers have attended NSF science institutes. Students were clearly falling behind in science (Helgeson, Blosser, & Howe, 1978; Stake & Easley, 1978; Weiss, 1978). In Case Studies in Science Education, Stake and Easley (1978) found a few elementary teachers with a strong interest and understanding of science; however, the number was insufficient "to suggest that even half of the nation's youngsters would have a single elementary school year in which their teacher would give science a substantial share of the curriculum and do a good job" (p. 19.3). In 1978 the National Assessment of Educational Progress (NAEP) completed the Third Science Assessment, which further supported the decline of science education and the need for reform (Yager & Penick, 1983).

As a response to the highly publicized reports, efforts to begin the reform of science education and education in general emerged in the United States. Politicians and educators alike focused their attention on reports such as Educating Americans for the 21st Century and A Nation at Risk (Gardner, 1983) (efforts supporting the need for educational reform). Educational reform as defined by Hurd (1985) "refers to qualitative changes in goals, curriculum, and learning that should be made for reasons supported by data and logic" (p. 91).

The science education studies interpreted and synthesized in "Project Synthesis" (Penick & Yager, 1986) set the groundwork for educational reform in science education. "Project Synthesis" established the criteria for setting standards in science K-12 (Yager, Aldridge, & Penick, 1983). The National Research Council hopes to have consensus
for those standards from academia, scientists, and educators by 1996 (Beardsley, 1992). With the development of standards for K-12 science education will come reform in science education through systemic changes that influence the whole educational systems (Beardsley, 1992).

The educational movement of the 1980s focus on "Back to Basics" lead to deemphasizing elementary science (Gerlovich, Davis, & Magrane, 1981; Orlich, 1980; Yager, 1983). The current national reform movement in science education has caused American scientists and science educators to redefine what all children should know, know how to do, and be disposed to do in the area of science.

Elementary school science as set by the parameters of this research is best defined by Brown and Butts (1983) as

an integral part of the elementary school . . . curriculum [which] provides for the daily opportunities for the sequential development of basic physical and life science concepts, along with the development of science process and inquiry skills . . . fostering in children an understanding of, an interest in, and an appreciation of the world in which they live. (p. 110)

The watchword of the movement for reform in the 1980s and 1990s in science education has become scientific literacy (Hurd, 1986; Rutherford, 1989; Yager, 1983; Yager & Harns, 1981).

Scientific literacy as defined by Project 2061 (Rutherford, 1989) is "an understanding of those aspects of science that are essential for full participation in a democratic society . . . for all students" (Michigan State Board of Education, 1991, p. 3). The scientifically literate person is one who possesses an inquiring mind, a positive attitude toward science, and a healthy view of one's own ability to understand and use
science. The scientifically literate person has a sound knowledge base of scientific concepts, systems, and process skills which enable the individual to continue to learn (Rutherford, 1989).

The Board of Education for the state of Michigan has responded to the challenge set forth by Project 2061: Science for All Americans (Rutherford, 1989) through its Michigan Statewide Systemic Initiative (MSSI) (MSSI Vision Statement, 1991). MSSI will strengthen and focus the system’s momentum for enabling the state to break through the obstacles to achieving literacy for all students (Rutherford, 1989). The national reform movement in science is prompted in part by the profound economic, civic, and demographic changes that threaten the nation's economic competitive edge (Gardner, 1983). The delivery of science in the elementary science classroom remained unchanged during the reforms of the 1950s, 1960s, and 1970s (Hurd, 1985; Yager & Penick, 1983; Yager & Stodghill, 1979). Several studies indicated the scarcity of science in the elementary classroom has been caused by the teacher's inadequate science background (Manning, Esler, & Baird, 1982; Weiss, 1978; Yager & Stodghill, 1979). Teachers' perceptions of their inadequate preparation (Enochs & Phares, 1982; Horn & James, 1981; Spooner & Simpson, 1979; Weiss, 1978), poor attitudes toward science, lack of materials (Stake & Easley, 1978), lack of time (Enochs & Phares, 1982, Goodlad, 1983; Hiatt, 1979), inadequate preservice education programs (Butts & Yager, 1980; Gallagher & Yager, 1981), and the lack of in-service training (Mechling, Stedman, & Donnellan, 1982) have been reported as obstacles for teaching science in the elementary classroom.
The changes needed to maintain the nation's economic competitive edge demands that the entire work force and citizenry achieve scientific literacy. Thus, educators are confronted with a double challenge: economic and civic demands to meet ever higher standards in science education, coupled with demographic trends that make success difficult even by the old standards (Hurd, 1985; MSSI, 1991).

Making the transition from traditional science education to the kind and quality of science education that will enable all students to attain scientific literacy is an enormous change. The kind of teaching the change necessitates will be demanding and complex, but attainable.

Studies of the barriers of good elementary school science continues to focus on the teacher in the classroom. These barriers can be eliminated through science in-service education focusing on constructivist teaching and learning. The paradigm shift from students absorbing knowledge to that of students constructing knowledge is called the "constructivist" approach (Resnick & Chi, 1988). According to Resnick and Chi, constructivist learning involves the student in interpreting and understanding new content and linking new knowledge to existing knowledge in a meaningful way. Teaching for conceptual change, or "teaching for understanding" as it is called, is viewed as the mode of teaching that will effect the changes needed to produce a scientific literate society (Atkin & Karplus, 1962; Watson & Konicek, 1990).

Stake and Easley (1978) studies revealed that for all the science learned, the teacher is the "enabler, the inspiration, and the constraint" (p. 19.1), making science in-service for elementary teachers a top priority in the science reform movement of the 1990s. In-service education
denotes programs that are based on identified needs, planned and designed for a specific group of individuals in the school district, have specific set of learning objectives or activities, and are designed to extend, add, or improve the job-oriented skills or knowledge (and may be referred to as staff development). (Orlich, 1984, p. 34)

In an effort to eradicate the problems of elementary science, at both the national and state levels in 1987, the American Institute of Physics (AIP) initiated Operation Physics. Operation Physics is a nationwide teacher training program established to improve the teaching and learning of basic physics (physical science) concepts, using a constructivist approach, in the upper elementary and middle school grades (4-8).

Statement of the Problem

Science education has been soundly criticized for not imparting to students the information which they need in a modern technological society. The rapidity and complexity of change in our society has created the need for the ongoing process of changing the way individuals view the learning and teaching of science within each classroom and beyond. If all students are to be equipped with the knowledge and skills needed to be active participants in the future, then educators must rethink science education.

Exacerbating this problem is the teacher's lack of confidence in his or her knowledge of science. The transformation of science instruction must include a serious commitment to teacher development because it is ultimately the classroom teacher who will make the transformation of how science is delivered in the classroom. In-service education will be a major determinant in changing the existing paradigms.
In an effort to change the teaching and learning of physics concepts in the elementary classroom, Michigan Operation Physics has established a series of staff development programs. The purpose of this study was to determine if Michigan Operation Physics has enhanced elementary teachers' knowledge of physical science and their delivery skills in the classroom. This purpose was viewed from the perspective of four research questions.

1. Did both Michigan Operation Physics participants and non-Operation Physics participants perceive the science in-services attended to be effective?

2. Did the instructional strategy of teachers change after participation in Michigan Operation Physics in-services as perceived by both the teacher and principal?

3. Did teachers' conceptual understanding of physical science improve after participation in Michigan Operation Physics in-services as perceived by both the teacher and principal?

4. Are there differences in perceptions of the principals' support of elementary science as perceived by Michigan Operation Physics participants and the non-Michigan Operation Physics participants and the principals of those teachers?

This investigation, which focused on the teacher, may serve as one factor in substantiating the impact of Michigan Operation Physics on the teaching of science in the elementary classroom. In establishing the areas of impact, aspects of Michigan Operation Physics in-service education programs may be evaluated more closely and incorporated into other science in-service programs for the elementary teacher.
Need and Significance of the Study

The importance of in-service education programs such as Operation Physics was pointed out in the previous section. The state of Michigan has been funded by the National Science Foundation (NSF) for its strategically-focused, 5-year initiative to restructure and transform science and mathematics education in the state. Public Act 25 of 1990, a complex education reform package, provides funds to encourage local school districts to adopt or adapt the State Board's Model Core Curriculum Outcomes for all students in Grades K-12. Both documents call for extensive in-service of Michigan teachers in science and mathematics.

The state of Michigan presently supports an array of in-service initiatives for elementary science and mathematics teachers. The state of Michigan conducted a statewide assessment in science and mathematics education in 1988-89. Survey results established continuing efforts to strengthen teachers' background through in-service education as a priority need for the state of Michigan. National, state, and local surveys and studies (Hirsch, 1983; Kleekamp, 1987; Weiss, 1987) have documented that few elementary teachers feel very qualified to teach physical science. Obviously, teachers cannot teach what they do not know and they are unlikely to risk teaching in areas where they feel inadequate or uncomfortable. According to Lawrenz (1986) and Layman (1982), elementary teachers are least prepared to teach physics concepts.

The basic premise of this study is that Michigan Operation Physics in-service programs have impacted its participants positively and could
be considered beneficial to all elementary teachers of science. The effective components of this program can be delineated and offered as a model for science in-service programs in which all elementary teachers of science will benefit. It also looks at both the teacher's and principal's perceptions of the principal's support of the teaching of elementary science.

Summary

This chapter presented an introduction to the study. Included was a description of the background of the problem, the educational trends related to the problem, the statement of the problem, the research questions being studied, and the purpose and importance of the study.
CHAPTER II

REVIEW OF LITERATURE

Introduction

The purpose of this chapter is to summarize the literature as it relates to a major challenge in science education today. That challenge is to provide quality science in-service education for elementary teachers. The National Science Teachers Association (1978) affirmed this challenge by stating that "the consensus, among science educators, is that quality in-service education is the health of science teaching as a whole factor and the factor most in need of continuous attention" (p. 29).

In an effort to establish a rationale for this study, the review begins with an early historical perspective of in-service education of science teachers. As researchers began to investigate the problems facing elementary teachers, they began to realize that this period is fraught with uncertainties for elementary teachers that demand special attention if a science literate society is to be developed by the 21st century. The review continues to the present, tracing the path of concern for elementary teachers. Finally, the history of Michigan Operation Physics, an established science in-service program for elementary teachers and middle school teachers is reviewed.
Postwar Era (1945-1955)

With the onset of many technological achievements such as radar, infrared photography, and nuclear energy, few people realized the relationship between the shortage of trained scientists and a shortage of trained science teachers.

Despite recommendations to the federal government, it was industries such as General Electric and Westinghouse Educational Foundation, starting in 1945, that established summer institutes and programs whose objectives included the improvement of high school science teaching.


During this period, in-service activities for science teachers were initiated by industries that were interested in upgrading the subject matter of science teachers. Despite recommendations to the contrary, the focus of in-service activities shifted away from local, instructional problems and returned to upgrading science teachers in subject matter on a national level.

The Rise of the National Science Foundation (1955-1970)

The National Science Foundation (NSF) was established by the U.S. Government in 1950 and given a mandate to improve science education. However, it was not until 1955 that NSF began supporting the in-service education of science teachers. This mandate led to a shift
of the science education efforts of the NSF from college to high school.

The shift was due, in part, to the realization that "a most critical and immediate limiting factor in developing latent science talent in the youth of the U.S. was the dwindling supply of adequately trained science teachers" (National Science Foundation [NSF], 1956, pp. 70-72). Also contributing to this shift was congressional pressure, partially due to a publication by DeWitt (1955), Soviet Manpower, that indicated Russia was producing trained scientists and technicians at an impressive rate.

In 1955, NSF began supporting various in-service training efforts for science teachers. One such effort was the institute programs that included summer, academic-year, and in-service institutes. Summer institutes provided subsidized opportunities for science teachers to receive subject-matter training during the summer. Academic-year institutes allowed a teacher to take a leave of absence from teaching and attend special, full-time programs at a university. In-service institutes provided an opportunity for teachers to receive subject-matter training during evenings or Saturdays during the academic year.

During this period, NSF spent $4 million for course content improvement programs, for the purpose of supporting teams of scientists, science educators, and science teachers to develop new curricula for secondary science.

The growth of these programs was modest until 1957, when the launching of Sputnik by the Soviet Union brought to national awareness the strength of Soviet technology and stirred public demand in the U.S. for more education in the sciences (Hausman, 1978). The result was
that the number of institutes supported went from 29 in 1956 to 133 in 1957, to 230 in 1958, and 607 in 1959. In 1959 alone, 30,523 teachers participated in institutes compared with 1,390 in 1956 (Crane, 1976, p. 88). Despite the efforts, findings showed only 7% of teachers at the elementary level participated in the institutes.

The middle to late 1960s was the most active time for NSF in-service programs for science teachers. Hausman (1978) claimed that 1965 was the peak year with $40 million supporting 37,000 teachers at 492 summer institutes, 64 academic-year institutes, and 313 in-service institutes. Lomask (1977), on the other hand, claimed 1968 was the peak year with $43.8 million supporting 43,612 teachers at 518 summer institutes and 183 academic-year institutes.

It is evident from the number of in-service education opportunities, the number of participants, and the dollars spent, that the period of NSF domination had a profound impact on in-service education of science teachers. The significance of this period has been expressed by several educational leaders. According to Kriehbaum and Rawson (1969),

In the long view of history, possibly the greatest contribution will be that NSF institutes . . . helped to focus an evolving philosophy of teacher training on a key idea: That subject-matter courses should receive essential emphasis. The "workshop" idea that centered around how-to courses has been supplanted by subjected-oriented work, such as that given in institutes. This key idea has been adopted not only for other educational areas in the U.S. but by foreign countries. (p. 333)

During this period, many opportunities were available for science teachers to update and upgrade themselves in their knowledge of subject matter. There were also opportunities for teachers to become involved in curriculum development and implementation. Opportunities
abounded because the nation placed a high priority on in-service education for science teachers. Unfortunately, with all these opportunities, very little focus was given to the improvement of science education for the elementary teacher.


The period was characterized by a decline in both the quantity and quality of in-service education for science teachers. This decline in in-service programs was evident by the fact that in 1976 there were no more institutes or curriculum implementation programs supported by NSF.

A review of the literature failed to show, with the withdrawal of federal support for in-service education of science teachers, that the impetus established by NSF programs was continued by state and local school agencies or by colleges and universities during this period.

**Dilemma in the In-Service Education of Elementary Science Teachers**

The history of in-service education of science teachers, previously described, revealed that the number and variety of opportunities peaked in the 1960s. The study also revealed that during the 1960s and 1970s the responsibility for in-service education had shifted to the federal government.

The three major National Science Foundation studies of the 1970s revealed that the problems of elementary science in the United States were as pronounced as ever (Helgeson, Blosser, & Howe, 1978; Stake &

In the 1980s the cry was "back to basics" thus causing the teaching of science to become lost in the "quest" for elementary schools to teach the classic "three Rs" (Mechling, 1983), thus creating a crisis in elementary science (Hurd, 1986; Yager, Bybee, Gallagher, & Renner, 1982; Yager & Penick, 1983).

Despite the reforms of the post-Sputnik age, and the hundreds of national reports and recommendations of the 1980s, the back-to-basics era did not alter the inadequate models of teaching and learning that currently define the content and pedagogy of elementary science education. With every crisis in education during the last half century, the same ideas for changing the context of science teaching have emerged (Hurd, 1985, 1986).

In the early 1990s, the pressure of a scientific/technological society has made it essential to match curriculum and teaching of science to a society described by Hurd (1985) as "characterized by cultural shifts, new values, a global economy, altered career patterns, changing lifestyles, and the exponential growth of knowledge" (p. 90). As state and national policies, driven by curriculum frameworks which define the knowledge, skills, and processes students need to know in each core curriculum, are established, states must ensure that both new and practicing teachers have the content knowledge and the instructional strategies that most effectively meet the needs of their students.

Thus, in-service education must be a key component of the overall educational reform effort. Beginning in the 1990s, the National Science
Foundation was mandated to ensure the vitality of science and technology in the United States. Its Teacher Enhancement (TE) Program supports development of effective approaches and creative materials for the continuing education of elementary, middle, and secondary school teachers of science, mathematics, and technology. This mandate has impacted local school districts as documented by the existence of a variety of exemplar staff development programs across the United States.

Research emphasizes the single most important contributor to a student's achievement in science is the student's teacher (Stake & Easley, 1978). If one accepts this assumption—that teachers are the major factor in influencing students' experiences and achievements in science—then it follows that improvement in student achievement would require a shift in the paradigm of teaching. The key to improved instruction is the teacher. It is essential that staff development programs result in meaningful changes in teachers' behaviors. According to Loucks-Horsley et al. (1989), it is most important that in-service instruction model the teaching strategies they want teachers to use.

If the results of research are to be applied (Harns, 1977; Harns & Yager, 1981; Yager, 1983; Yager & Stodghill, 1979) to correct these problems, the "traditional teaching" that exists in classrooms today must be changed (Lombard, 1983). Most science teachers embark upon a journey toward obsolescence as soon as they begin their career.

With the rapid changes in the society and throughout the world, science curricula and teaching are constantly changing, making many preservice programs seem obsolete. Voelker (1977) saw in-service
education as the most important facet of science teacher education. It is absolutely essential that in-service education become part of a continuous process for today's science teachers (Helgeson, 1978; Yager et al., 1982).

This perhaps accounts for the poor status of science instruction at the elementary level. Towe (1982) reported a study completed by Manning, Esler, and Baird on the status of instruction in the elementary schools of central Florida; 20% of teachers surveyed had never taken a science methods course and 60% had never attended science in-service training. Studies (Bethel, 1979; Horn & James, 1981; Manning et al., 1982) revealed that many teachers feel unqualified to teach science because of the few science courses taken during their undergraduate studies.

This lack of preparation is accompanied by a lack of self-confidence among teachers to teach science and is clearly manifested in their teaching practices. According to Manning et al. (1982), 25% of teachers surveyed reported teaching no science. Other surveys have shown similar results.

Because of this lack of instruction, "a whole generation of students has been short-changed" (AAAS, 1989, p. 5). This feeling of inadequacy has permeated reports making the need for effective science in-service of elementary teachers a top priority of the science education reform movement of the 1980s and 1990s.

Nationwide studies (Office of Technological Assessment, 1988) and need assessments in Michigan confirm that most elementary teachers lack the knowledge and skills requisite for teaching science
effectively in the classroom. These findings are particularly noticeable in the physical sciences. Unfortunately, as the quantity and quality of science in-service education diminished, the needs of elementary teachers have not.

In summary, there is a quandary regarding science education for elementary teachers. In the 1990s, there exists unique in-service education needs of the elementary teacher in science, combined with inaction of local school districts to respond to those needs. However, many of those needs can be addressed by continuous, quality in-service education programs.

Elements of Effective In-Service Education

Typologies, operational definitions, and taxonomies are still emerging (Harty & Enochs, 1985). In-service education has been seen by many in the past as ineffective and lacking clear goals and design. Gallagher and Yager (1981) reported survey results that indicated poor quality in-service programs and the lack of appropriate continuing education for in-service teachers were critical areas needing attention in the 1980s.

In an age of rapidly changing and expanding technology, pre-service education cannot adequately service classroom teachers. It is absolutely essential that in-service education become part of a continuous process for today's science teachers (Helgeson, 1978; Yager et al., 1982).

Research has consistently shown the need for new directions and a conceptual framework in science education (Gallagher & Yager, 1981;
Harty & Enochs, 1985). The areas of concern synthesized from the existing literature (Harty & Enochs, 1985) are: (a) the lack of generalizable models or conceptual frameworks along with acceptable definitions; (b) a lack of research or empirical base to make rational decisions; (c) the many functional or operational problems such as unrelatedness of activities to demand on-the-job concerns, ambiguous and nonresponsive reward mechanisms, and time demands associated with classroom teaching; and (d) the attitudes of teachers toward in-service education.

Joyce and Showers (1981) and G. M. Sparks (1983) revealed from synthesis of research an emerging definition and conceptualization of purpose and framework in science education. Staff development and in-service education, used interchangeably, is defined by G. M. Sparks (1983) as any training activity that attempts to help teachers improve teaching skills.

In conceptualizing the framework and purpose of science in-service, Joyce and Showers (1980) and Stallings (1982) noted that the purpose is twofold: fine tuning present skills or learning new ways of teaching.

According to Joyce and Showers (1980), tuning one's present skills means becoming better facilitators of the learning process by managing logistics more efficiently, improving the vividness and quality of lectures, improving technique of questioning students, and engaging students more in the learning process so that they are more productive. "Training oriented toward fine tuning consolidates our competence and is likely to increase effectiveness" (Joyce & Showers, 1980, p. 320).
Mastery of new techniques requires more intensive training than fine tuning. Mastery of new teaching strategies or models and/or implementation of new curriculum requires thinking differently, behaving differently, and helping students to adapt and become comfortable with the new approaches.

In Developing and Supporting Teachers for Elementary School Science Education, Loucks-Horsley et al. (1989) saw appropriate staff development programs as the key to the lasting transformation of science instruction. The most effective staff development activities as cited by Loucks-Horsley et al. (1989): (a) are continuous and ongoing; (b) model the constructivist approach to teaching that teachers will use with their students; (c) provide opportunities for teachers to examine and reflect on their present practices and to work with colleagues to develop and practice new approaches; and (d) provide good support structures within the group, among the group and the instructors, and from the school.

This combination of theory and application, practice, time to reflect, self-study, and cooperative learning rarely is a common practice of more traditional in-services, workshops, and college courses.

In-Service

Michigan Operation Physics is an in-service program designed to accomplish fine tuning of present skills as well as learning new ways of teaching. In-service for the purpose of fine tuning of skills consolidates one's competence and is likely to increase one's effectiveness. At the other end of the spectrum mastering new strategies or models and/or
learning new concepts is complex and should be done through understanding its rationale, implementation, and application; therefore, requiring more intensive training (Bethel, Ellis, & Barufaldi, 1982; Joyce & Showers, 1980; G. M. Sparks, 1983).

Levels of Impact

In-service education has been proposed as the final element in creating a good science program (Orlich, 1985). To ascertain through the literature how training contributes to learning, Joyce and Showers (1980) developed a typology of "levels of impact" (p. 380) of training and a categorization of training components. Joyce and Showers, in their essay on improving in-service training, concluded that regardless of the training agent, the outcomes of training can be classified into several levels of impact: awareness, the acquisition of concepts or organized knowledge, the learning of principles and skills, and the ability to apply those principles and skills in problem-solving activities. The awareness level focuses on the importance of the issue.

At the awareness level, one realizes the importance of an issue and begins to focus on it. With constructivist teaching, for example, the road to competence begins with awareness of the nature of constructivist teaching, its implication, and how it fits into the teaching of science.

Secondly, understanding of concepts provide intellectual control over the relevant content. Essential to constructivist teaching are knowledge of constructivist processes and how learners at various levels of cognitive development respond to constructivist teaching.
Principles and skills are the tools necessary for action. The skills required for constructivist teaching are learned. At this level there is potential for action due to awareness of the area, the ability to think effectively about it, and the skills needed to act.

Finally, through application and problem solving, the concepts, principles, and skills can be transferred to the classroom. The teaching strategies learned can be integrated into one’s continuous instructional style. Only after the fourth level has been reached can one expect impact on the education of children (Joyce & Showers, 1980).

In order to maximize the transfer of knowledge and skills to the classroom it is important to include several combinations if not all training components (Borg, Langer, & Kelly, 1971; Feldens & Duncan, 1978; Orme, 1966/1967; G. M. Sparks, 1983). The most effective training activities may be those that combine theory, modeling, practice, feedback, and coaching to application. The existing knowledge base indicates if these components are combined in in-service training, one can expect considerable outcomes at each level (Joyce & Showers, 1980).

Components of Training

Training elements are combined in various ways, whether the training is directed toward fine tuning of style or mastering new approaches. An analysis of the training literature by Joyce and Showers (1980, 1981, 1982) led to the identification of five major training components that have been studied intensively: (1) presentation of theory or description of skill or strategy, (2) modeling or demonstration of skills or models of teaching, (3) practice in simulated and classroom
settings, (4) structured and open-ended feedback (provision of information about performance), and (5) coaching for application (hands-on, in-classroom assistance with the transfer of skills and strategies to the classroom).

More than 200 studies were reviewed by Joyce and Showers (1980), none of which used all training components and measured effects at all levels of impact.

Stallings (1982) described a staff development model based on mastery learning. The components of the model are diagnosis, inform and discuss, guided practice and feedback, and posttest. G. M. Sparks (1983), combining the suggested activities by Joyce and Showers (1980) and Stallings (1982), recommended the following components of effective teacher in-service: (a) diagnosing and prescribing, (b) giving information and demonstrating, (c) discussing application, and (d) coaching.

The "meat-and-potatoes" of most teacher in-service is presentation of theory (giving information) or description of skill or strategy. Joyce and Showers (1981) stressed the importance of providing the rationale and theoretical base to raise awareness and increase conceptual understanding of a topic. However, research shows this component to be most effective when used in combination with other training components such as modeling to reinforce theory presentation in concrete means.

As conceptualized by G. M. Sparks (1983), demonstration has a broad meaning that includes live modeling, videotapes, and detailed narrative descriptions. Visualization is essential in practice. According
to Joyce and Showers (1980), modeling involves enaction of the teaching skill or strategy through a live demonstration with subjects or use of some form of media. It is apparent from the research that modeling is an essential training component aimed at the acquisition of complex skills and their transfer to the classroom situation.

Neither Stallings (1992) nor Joyce and Showers (1980) discussed application as a separate component. G. M. Sparks (1983) saw it as an opportunity for participants to interact and share successes and failures of tried strategies and techniques. There is growing evidence (G. M. Sparks, 1983) that small-group discussion of the application of and concerns about new techniques enhances the eventual adoption of new teaching practices.

Further, research indicates practice and feedback (Brophy & Good, 1974) result in significant changes in teacher-student interaction. Feedback may be structured or open-ended. Research analyzed by Joyce and Showers (1980) shows modeling followed by practice and feedback can be very powerful in achieving skill development and transfer.

The final activity is coaching, defined by Joyce and Showers (1980) as "hands-on, in-classroom assistance with the transfer of skills and strategies to the classroom" (p. 380). G. M. Sparks (1983) noted Joyce and Showers (1982) described the process of coaching as the provision of companionship, giving of technical feedback, analysis of when to apply a model and the effects of its application, adaption of the model to the needs of students, and interpersonal facilitation (support) during the practice period. This companionship could be an
administrator, curriculum supervisor, college professor, or teachers' peers.

Limited research on the impact of coaching suggests (Showers, 1983) peer coaching enhances the implementation of the recommended model.

Michigan Operation Physics: A Science In-Service Education Program

The historical analysis presented provides a backdrop for the need and context in which Operation Physics is introduced. The American Institute of Physics (AIP) is keenly aware of the current inadequacies of physical science education in the formative years (K-8). The middle grades (4-8) have been identified as particularly critical, because these grades are where students are developing fundamental concepts (Operation Physics, 1988), making initial career choices about further science study (Gardner, 1983), and laying the foundation for further study in science and mathematics.

AIP's initiative, Operation Physics, is a major nationwide effort designed to improve the teaching and learning of basic physics concepts in the upper-elementary and middle school grades. Michigan Operation Physics has two primary goals (Michigan Operation Physics, Center for Science Education): (1) to enhance upper elementary and middle school science teachers' understanding of physics and (2) to provide these same teachers with ideas for effectively teaching their students about physics.
To accomplish these objectives, the Michigan Operation Physics project has developed and validated a series of teacher workshops on the physics topics typically included in fourth through eighth grade science curricula. These workshops are provided by teams of exemplary science educators who have received training and support to conduct Michigan Operation Physics programs in their local areas.

Each Michigan Operation Physics team is composed of members who collectively provide the team with experience in upper elementary/middle school science teaching and a strong academic background in physics. All team members have demonstrated professional activity, proven leadership ability, and successful workshop presentation experience. Team members include: (a) university physics and science education faculty, (b) state and district science supervisors, (c) high school physics teachers, and (d) upper elementary and middle school teachers.

Michigan Operation Physics workshops merge content and practice and are flexible to meet local needs and restraints. Workshops are available on the 13 physics-related topics typically included in fourth through eighth grade. Each Michigan Operation Physics workshop features: (a) content and activities that reflect the findings of current research on teaching and learning, (b) a discussion of ideas that children are likely to bring with them into the classroom, (c) materials and ideas that teachers can use to enhance the teaching of any adopted science curriculum, (d) hands-on activities that are adaptable for use with students and that require only inexpensive and/or readily available materials, and (e) alignment with the Physical Science Outcomes of Michigan Essential Goals and Objectives.
The framework of the Michigan Operation Physics workshops has proven highly successful. Results of a study conducted by an independent evaluator suggest that 35 hours of Michigan Operation Physics instruction significantly reshapes the way teachers present science to students.

In summary, the researcher established a need for continuous science in-service education for elementary teachers and provided a chronology of events in science in-service education leading into the 21st century. Establishing a research base for this study allowed the collection of empirical data based on criteria for effective in-service education strategies as delineated in the literature.
CHAPTER III

METHODOLOGY

Organization of Methodology

Presented in this chapter is the research methodology that was used to examine both the teachers' and principals' perceptions of the impact of Michigan Operation Physics (MOP) on the teaching of science in the elementary classroom. Population and sampling procedures are described; the various instruments are enumerated along with a rationale for their use. The pilot study and data collection procedures are discussed. Finally, the procedures for analyzing the data in this study are detailed.

Population

The criteria used by the researcher for the purpose of identifying the accessible population were: (a) the teachers must teach at the elementary level (Grades 1 through 6) and (b) there must be at least three teachers trained in Michigan Operation Physics within each building from which teachers were selected to participate in the study. In some geographical areas only middle school teachers had received Michigan Operation Physics training; therefore, those areas were not included in the study. Because of the established criteria, only 9 of the 11 existing geographical areas formed an accessible population (see Appendix A).
The accessible population represented 16 Michigan schools (16 principals) and 78 Michigan Operation Physics participants.

Sample Selection

Michigan Operation Physics in-services are provided by teams of exemplary science educators who have received training and support to conduct Operation Physics teacher training programs in their local areas. Each Operation Physics team is composed of at least three members who collectively provide the team with experience in upper elementary and middle school science teaching and a strong academic background in physics. To facilitate teacher training programs within the various geographical areas, a contact team member is identified for each team.

To access this population, a letter of intent (see Appendix B) was sent to the contact team members in each of the nine geographical areas involved in this study by the Michigan Operation Physics director. The letter introduced the researcher and requested cooperation in this study. In February 1993, a letter was sent to each contact team member by the researcher requesting the names of Michigan Operation Physics participants, the school address, and the name of the principal of each school. The Michigan Operation Physics accessible population for the study was obtained from the lists submitted by the contact team members.

The contact team members provided the researcher with the names of the principals of those teachers who had participated in Michigan Operation Physics. Teachers within those buildings who had not received Michigan Operation Physics training were randomly selected to
participate in this study for the purpose of contrasting the perceptions held by the two groups, Michigan Operation Physics participants and those teachers who had not received Michigan Operation Physics training. The names of those elementary teachers who had not received Michigan Operation Physics training were provided by the principals of the MOP accessible population (see letter requesting names in Appendix C). From the population of non-Michigan Operation Physics participants, 33 teachers were randomly selected, using a table of random numbers (Borg & Gall, 1983) for participation in this study.

Instrumentation

The purpose of this study was to determine the impact of Michigan Operation Physics training on the teaching and learning of basic physics concepts, as perceived by both the teachers and the principals of those teachers who participated in Michigan Operation Physics. The impact of MOP training is delineated through four research questions:

1. Did both Michigan Operation Physics participants and non-Michigan Operation Physics participants perceive the science in-services attended to be effective?

2. Did the instructional strategy of teachers change after participation in Michigan Operation Physics in-services as perceived by both teachers and principals?

3. Did teachers’ conceptual understanding of physical science improve after participation in Michigan Operation Physics as perceived by both teachers and principals?
4. Are there differences in perceptions of the principals' support of elementary sciences as perceived by Michigan Operation Physics participants and the non-Michigan Operation Physics participants and the principals of those teachers?

Factors which determined the effectiveness of the in-services included the established criteria of effective in-services based on the review of literature (Joyce & Showers, 1980; Lawrence, 1974; McLaughlin & Berman, 1977), teachers' perceived changes in attitude and principals' perception of teachers' attitudes. Perceived changes in instructional strategies were measured based on teachers' and principals' responses to practices of hands-on, inquiry-based instruction in the classroom, as compared to other instructional strategies. The perceived conceptual understanding of basic physics concepts was measured by increased time spent teaching science concepts and the teachers' and principals' perceptions of the teachers' confidence with physical science concepts. Lastly, differences in perceptions of the principal's support of elementary science as perceived by all participants in this study were measured on criteria established by Mechling and Oliver (1982).

This study was conducted using three separate instruments developed by the researcher emulating a questionnaire designed by Leonard (1986/1987). The questionnaire items used for this study evolved from issues considered to be pertinent from the literature review. The three separate questionnaires developed for this study included one instrument for Michigan Operation Physics participants (Appendix D), one for teachers in the same schools who had not participated in Michigan Operation Physics (Appendix E), and one for principals of those
teachers involved in this study (Appendix F).

The questionnaire for Michigan Operation Physics participants was designed to determine the perceived effectiveness of the in-service: (a) how the in-service impacted the instructional strategies used by the teacher, (b) how the in-service impacted the professional growth of the teacher, and (c) the teacher's perception of the principal's role as a science leader. Each teacher questionnaire covered six areas: professional background, effectiveness of science in-service, instructional strategy, professional growth, administrative support, and district support.

The questionnaire for non-Operation Physics participants was a two-part instrument. Part I was designed for teachers who participated in science in-service other than Michigan Operation Physics over the past 3 years with many of the same questions asked of Michigan Operation Physics participants. Part II was designed for those teachers who had not participated in any science in-service over the last 3 years and, therefore, attempted to determine reasons for lack of participation.

The questionnaire administered to principals sought to determine the principal's perception of Michigan Operation Physics impact on the teacher's content knowledge and method of teaching. The questionnaire sought to identify perceived differences, if any, between those teachers who had participated in Michigan Operation Physics and those who had not. In addition, it sought to identify the principal's perception of his or her role as a science leader and its impact on the classroom teacher.

The instruments for the study were designed by the researcher. Clear and concise instructions, attractiveness, and ease of response
were sought in the design of the instruments as a checklist. The instru­ments were reviewed by three readers, including the researcher's advi­sor, for the purpose of providing feedback on the instructions given for completion of the instruments, the content of the instruments, and the clarity with which the information was presented. The instruments were revised reflecting the feedback of the reviewers. There were 37 response items on the teacher questionnaire and 25 response items on the principal questionnaire. There were 26 response items for those teachers who had not participated in any science in-service during the last 3 years. The questions presented a number of possible responses and the respondent was asked to check the most appropriate response. Each teacher had to rank order his or her responses to three of the survey items and each principal had to rank order his or her responses to four of the survey items.

Pilot Test and Data Collection Procedure

The pilot test was conducted in April 1993. The pilot population consisted of teachers from those schools with two or less MOP particip­ants. A letter requesting participation in the piloting of the research instrument was sent to those teachers and their principals (see Appendix G). The letter outlined the study procedure and assured the respondents of confidentiality. The instrument was mailed with a preaddressed stamped envelope for its return. Respondents were asked to critique the instrument for clarity and validity of questions asked.

The questionnaire was revised according to recommendations from the pilot test group that (a) several choices of responses needed
clarification and (b) suggested responses were provided as a choice for selection. The specific revisions to the instruments used for Michigan Operation Physics participants (Appendix D), non-Michigan Operation Physics participants (Appendix E), and principals (Appendix F) were accomplished.

In early May 1993, a letter of introduction (see Appendices D, E, and F) and a questionnaire were sent to Michigan Operation Physics participants selected for the study, randomly selected co-workers who were non-Michigan Operation Physics participants, and their principals. The letter requested cooperation in conducting the study by asking that they complete and return the questionnaire. Respondents were assured of the confidentiality of their responses. A preaddressed stamped envelope was included for the respondent to return the questionnaire by May 12, 1993.

After 2 weeks, a second letter was sent to those who did not respond (see Appendix H). Finally, a follow-up telephone call was made to each principal, as needed, to assure returns. After this final follow-up the data collection was terminated and the remaining subjects were declared nonrespondents.

Data Analysis Procedure

The purposes of the study were to describe the impact of MOP on the teaching of physical science in the elementary classroom as perceived by the teacher and the principal (a) by identifying the most frequently used instructional strategies in the classroom after participation in MOP, (b) by describing the teachers’ conceptual understanding of
physics concepts after participation in MOP as perceived by both teachers and principals, (c) by describing perceived attitudes of teachers after participation in MOP, and (d) by examining the principal's role in science education and support provided as perceived by both the principal and the teacher.

The information gathered by this research provides a framework for describing the impact of MOP on the teaching of physical science in the elementary classroom. Therefore, it was appropriate to use frequency distributions to report the data. According to Hinkle, Wiersma, and Jurs (1979), "the development of the frequency distribution systematically organizes the data and gives the researchers some indication of the nature of the data" (p. 12).

Questions 9-12, 14, 19, and 29 of the MOP teacher questionnaire and Questions 9-19 of the non-MOP participants relate to the first research question. Results were analyzed to determine perceived effectiveness of the in-services, teachers' perceptions of changes attributed to in-service experiences, and perceived professional changes. Questions 21-28 of the teacher questionnaires and Questions 11, 12, and 15-21 of the principal questionnaire relate to the second research question. The purpose of which was to determine the perceived changes in instructional strategies used in the classroom.

Questions 19-20 and 25 of the MOP teacher questionnaire, Question 20 of the non-MOP questionnaire, and Question 13 of the principal survey relate to the third research question. The questions were designed to determine the perceived improvement of teachers' conceptual understanding of physics concepts. Questions 30-36 of the teacher
questionnaires and Questions 20-23 of the principal questionnaire relate to the fourth research question. The results were analyzed to determine the perceived role of the principal in supporting and promoting science education in the elementary school.

The data obtained from these questions were then examined on the following basis: The questionnaires were designed as a checklist. For each group, respondents were directed to check all possible responses that applied for each question. The raw data were calculated based on the selected responses for each question within the three responding groups. The frequency and percentage for each question was completed based upon the number of times the response was selected in relation to the total number of possible selections. Based on the percentages, MOP and non-MOP responses to corresponding questions were compared for each item. Respondents were directed to rank order their responses to Questions 21, 22, and 34 of each teacher questionnaire and Questions 11, 12, 15, and 19 of the principal questionnaire. The participants were requested to rank order their responses from one to seven, with one representing the most important and seven indicating the least important of those responses. Each group's responses were rank ordered based on calculated means. Comparisons of the teachers' and principals' perceptions were made based on the calculated means.

The findings were reported in terms of the four research questions:

1. Did both Michigan Operation Physics participants and non-Operation Physics participants perceive the science in-services attended
to be effective?

2. Did the instructional strategies of teachers change after participation in Michigan Operation Physics in-services as perceived by both the teachers and principals?

3. Did teachers' conceptual understanding of physical sciences improve after participation in Michigan Operation Physics as perceived by both teacher and principal?

4. Are there differences in perceptions of the principal's support of elementary science as perceived by Michigan Operation Physics participants, non-Michigan Operation Physics participants, and the principals of those teachers?

Summary

In this chapter the design and methodology of the study were examined in detail. The population, sampling, data collection, and analysis procedures to deal with study objectives were described.
CHAPTER IV

ANALYSIS OF DATA

Introduction

The purpose of this study was to describe the impact of MOP on the teaching of physical science in the elementary classroom as perceived by both the teacher and the principal. The impact of Michigan Operation Physics (MOP) training is delineated through four research questions designed (1) to determine the effectiveness of the in-services as perceived by both Michigan Operation Physics participants and non-Michigan Operation Physics participants, (2) to identify the perceived changes in teachers' instructional strategies after participation in Michigan Operation Physics in-services, (3) to determine if teachers and principals perceived teachers' conceptual understanding of physics concepts improved after participation in Michigan Operation Physics, and (4) to determine the principals' role and support of elementary science as perceived by all participants in this study.

The frequencies and percentages for each item of the three questionnaires were calculated. Responses were analyzed according to the four study objectives.

The results obtained from the analysis of the data are presented in this chapter. Included are: (a) descriptive statistics, (b) other findings, and (c) summary of the results.
Descriptive Statistics and Findings

This study was conducted with teachers and principals from 16 elementary schools in southwestern Michigan. The MOP participants were selected based on the established criteria: (a) each participant is an elementary teacher and (b) at least three teachers have received MOP training within each building from which the participants are selected. Non-MOP participants were randomly selected from each building of the MOP participants. Principals of all participants were selected to participate in this study. Distribution of returns is presented in Table 1.

Table 1

<table>
<thead>
<tr>
<th>Questionnaires</th>
<th>MOP</th>
<th>Non-MOP</th>
<th>Principals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sent</td>
<td>77  100.0</td>
<td>33  100.0</td>
<td>16  100.0</td>
</tr>
<tr>
<td>Final usable returns after follow-up</td>
<td>37  48.1</td>
<td>11  33.3</td>
<td>11  68.8</td>
</tr>
</tbody>
</table>

Before the initial follow-up, 54.5% of the principals responded. A record of the response rate before follow-up for the other respondents was not maintained by the researcher. Based on criteria established by the researcher, middle school teachers, a large population of Michigan Operation Physics training, were excluded from this study. The other criterion limiting the scope of this study was the critical mass of Michigan Operation Physics teachers sought in each building. The relative
small selected population coupled with the fact that the questionnaires were mailed in early May, contributed significantly to the low response rate by each group. These are all factors that may interfere with the validity of this study and limit the generalizability of the results.

The teacher questionnaire was organized into the categories of professional background, effectiveness of science in-service, instructional strategy, professional growth, administrative support, and district support. The importance of professional background data was to provide a description of the sample and support its representation of the population. Responses to these items are summarized in Table 2.

Only 37.8% of MOP participants represented their major as elementary education compared to 27.3% of non-MOP participants with the same major. The majority of the respondents, 51.4% of MOP and 81.8% of non-MOP participants represented their major as "other." In the category of other, one MOP respondent indicated a major in mathematics, one indicated a major in interdepartmental science, and four respondents indicated a minor in mathematics or science. In comparison, one non-MOP respondent indicated a major in general science and one a minor in biology. The data represent a clear lack of science majors at the elementary level.

The respondents' years of teaching experience as represented in Table 2 indicate the majority of MOP (73%) and non-MOP participants (63.6%) have 6 or more years of experience. Fifty-seven percent and 36% of MOP and non-MOP respondents, respectively, reported having bachelor's degrees. Forty-three percent and 64% of MOP and non-MOP respondents, respectively, reported having master's degrees. The
### Table 2
General Characteristics of Teachers in Survey

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>% of MOP (n = 38)</th>
<th>Non-MOP (n = 11)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Undergraduate academic major:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elementary education</td>
<td>37.8</td>
<td>27.3</td>
</tr>
<tr>
<td>Social science</td>
<td>16.2</td>
<td>0.0</td>
</tr>
<tr>
<td>Music</td>
<td>5.4</td>
<td>0.0</td>
</tr>
<tr>
<td>Special education</td>
<td>2.7</td>
<td>0.0</td>
</tr>
<tr>
<td>Language arts</td>
<td>13.5</td>
<td>9.1</td>
</tr>
<tr>
<td>Other</td>
<td>51.4</td>
<td>81.8</td>
</tr>
<tr>
<td><strong>Years of teaching experience:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-5 years</td>
<td>27.0</td>
<td>36.4</td>
</tr>
<tr>
<td>6-10 years</td>
<td>18.9</td>
<td>0.0</td>
</tr>
<tr>
<td>11-15 years</td>
<td>8.1</td>
<td>18.2</td>
</tr>
<tr>
<td>16-20 years</td>
<td>27.0</td>
<td>9.1</td>
</tr>
<tr>
<td>21-25 years</td>
<td>13.5</td>
<td>18.2</td>
</tr>
<tr>
<td>26 or more years</td>
<td>5.4</td>
<td>18.2</td>
</tr>
<tr>
<td><strong>Highest degree earned:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bachelor's degree</td>
<td>56.8</td>
<td>36.0</td>
</tr>
<tr>
<td>Master's degree</td>
<td>43.2</td>
<td>64.0</td>
</tr>
<tr>
<td><strong>Primary grade level being taught:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K-1</td>
<td>5.7</td>
<td>9.1</td>
</tr>
<tr>
<td>2-3</td>
<td>34.3</td>
<td>45.5</td>
</tr>
<tr>
<td>4-6</td>
<td>60.0</td>
<td>45.5</td>
</tr>
</tbody>
</table>

*Note: Percentage of valid cases, excluding missing cases.*

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
The majority of teachers taught in self-contained classrooms (MOP = 86.5% and non-MOP = 100%). The grade distribution was fairly even with Grades 4-6 being the most commonly taught.

The grade level at which the majority of teachers were teaching is consistent with the major focus of Operation Physics training, upper elementary and middle school. However, 91.7% of MOP respondents indicated participation in Michigan Operation Physics was voluntary compared to 100% voluntary participation by those teachers who participated in other science in-services over the last 3 years.

These teachers appear to be generally representative of elementary school teachers and the characteristics reported are similar to those reported for a random sample of teachers (Lawrenz, 1986). According to the study of 333 elementary teachers from throughout the state of Arizona, 65% had bachelor’s degrees in elementary education. Teachers had from 1 to 33 years of teaching experience with 60% having taught 10 years or less. Forty-seven percent reported having master’s degrees. Seventy-three percent of the teachers taught in self-contained classrooms with sixth grade being the most commonly taught grade. It should be kept in mind, however, that these teachers were probably positively biased because 91.7% of MOP respondents and 100% of non-MOP respondents voluntarily participated in the staff development program.
Research Questions

Perceived Effectiveness of MOP Training

Did both Michigan Operation Physics participants and non-Operation Physics participants perceive the science in-services attended to be effective?

Teachers' and principals' perceptions of the effectiveness of Operation Physics as it relates to the teaching of elementary science were positive as indicated by their responses in several categories. The in-services were perceived effective by 100% of the 35 MOP respondents. The most effective area of the in-services as perceived by 81.1% of the MOP respondents was the concrete, specific training provided for teachers. Seventy-one percent of those responding perceived that there was a continuous modeling of concepts by the in-service presenters. Seventy-seven percent of MOP respondents perceived that there was time allowed for supervised practice. Sixty percent of the respondents indicated thorough, clear presentation of theory behind the approach modeled. Sixty-two percent responded that the teaching and learning styles modeled were applicable to the classroom.

One hundred percent of the non-MOP respondents (5) who attended some type of science in-service over the last 3 years perceived the in-services to be effective. However, in contrast, MOP participants were more specific and positive in perception of in-service transfer of skills and knowledge to the participants. They further perceived the in-services as an ongoing effort. The perception of non-MOP participants was less positive as it relates to in-service transfer of skills and...
knowledge to participants. Non-MOP participants (60%) perceived the in-service as a one-shot effort. However, both MOP and non-MOP respondents have a low perception of their abilities to transfer the skills and knowledge attained to their individual classrooms. Given the differences in the perception of skills and knowledge attained through the inservices, it is notable the similarity in both groups teachers' perceptions of their ability to transfer the skills and knowledge attained in the inservices to the classroom. Table 3 indicates the characteristics of inservices as perceived by teachers.

Table 3
Effectiveness of Michigan Operation Physics In-Service

<table>
<thead>
<tr>
<th></th>
<th>Non-MOP participants (n = 5)</th>
<th>MOP participants (n = 37)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Provided concrete, teacher specific training</td>
<td>40</td>
<td>81.1</td>
</tr>
<tr>
<td>Continuous modeling by in-service presenters</td>
<td>80</td>
<td>71.4</td>
</tr>
<tr>
<td>Time for supervised practice</td>
<td>40</td>
<td>77.1</td>
</tr>
<tr>
<td>&quot;One-shot&quot; effort</td>
<td>60</td>
<td>27.0</td>
</tr>
<tr>
<td>Provided materials that could be developed locally</td>
<td>60</td>
<td>71.4</td>
</tr>
<tr>
<td>Provided time for participant interaction</td>
<td>40</td>
<td>72.3</td>
</tr>
<tr>
<td>Teaching and learning applicable to individual classroom</td>
<td>60</td>
<td>62.9</td>
</tr>
<tr>
<td>Thorough, clear presentation of theory behind approach modeled</td>
<td>40</td>
<td>60.0</td>
</tr>
</tbody>
</table>

Note. Respondents could check more than one answer.
Teachers in the sample were asked to rate the impact of MOP in-services on their attitudes toward science and the teaching of science. "Attitude is more positive" was the response of 82.4% of the respondents.

Studies (Gabel, Kagan, & Sherwood, 1980; Lawrenz, 1984; Orlich, 1985) relating to in-service programs for elementary teachers focus on attitude changes as the most crucial factor of importance. When principals were asked about the attitudes of teachers who participated in Michigan Operation Physics, the responses were consistent with those of the MOP participants. "Teachers are more enthused about teaching science" as indicated by 63.3% of responding principals.

The impact of MOP on teachers was further analyzed based on the responses as shown in Table 4. MOP participants who felt they became more knowledgeable about science concepts (73%) and about the skills necessary to teach science represent 46% of the respondents, while 51.4% indicated there was an enhancement of attitude toward science and the teaching of science. Strategies necessary to gain adequate support for teaching science in the classroom were learned by 29.7% of the respondents, while 13.5% of respondents became more aware of the impact of science in society.

Non-MOP participants' responses indicate a lower perception of their skills and understanding of science than MOP participants. However, non-MOP participants indicated an enthused attitude toward science and the teaching of science as a result of their in-service experiences. In contrast, MOP participants' perception of their skills and knowledge was enhanced by the in-services. However, their attitude
Table 4
Teachers' Perceptions of Changes Attributed to In-Service Experiences

<table>
<thead>
<tr>
<th>Changes experienced</th>
<th>MOP participants</th>
<th>Non-MOP participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Became more knowledgeable about science concepts</td>
<td>27</td>
<td>73.0</td>
</tr>
<tr>
<td>Became more knowledgeable about the skills of science</td>
<td>17</td>
<td>46.0</td>
</tr>
<tr>
<td>Became more aware of the impact of science on society</td>
<td>5</td>
<td>13.5</td>
</tr>
<tr>
<td>Learned strategies needed to gain support for the teaching of science</td>
<td>22</td>
<td>29.7</td>
</tr>
<tr>
<td>Enhanced attitude toward science and science teaching</td>
<td>19</td>
<td>51.4</td>
</tr>
</tbody>
</table>

Note. Respondents could check more than one answer. Number of MOP participants = 37. Number of non-MOP participants = 5.

toward science and science teaching was not influenced as much as non-MOP participants were by their in-services.

Michigan Operation Physics participants reflect a decreasing perception of their actual abilities to teach science in the classroom (46%) even though they feel more knowledgeable about science concepts (73%). All participants' response to the survey questions were made after returning to the classroom. All participants show little confidence in their ability to transfer their experiences to their students.
According to Brophy and Good (1974), practice and feedback result in significant changes in the student-teacher interaction. Modeling followed by practice and feedback (Joyce & Showers, 1980) along with peer coaching as suggested by Joyce and Showers (1982) enhances the transfer of skills and strategies into the classroom. Given that 51.4% of the MOP respondents indicated enhanced attitudes toward science and the teaching of science, the perception of their abilities to teach science did not improve. Only 29.7% of MOP participants felt they had learned strategies needed to gain support for the teaching of science compared to 60% of non-MOP respondents. Continuous staff development, practice, feedback, and peer coaching are necessary components to overcome deeply held perceptions about the lack of skills necessary to deliver science in the classroom.

When teachers were asked to indicate "changes you have experienced" as a result of MOP, 64.9% indicated they plan and teach science differently. In contrast, 80% of non-MOP participants who participated in science in-service indicated they plan and teach science differently. When principals were asked who assists with the development of elementary science curriculum, 45.5% indicated those teachers who have participated in MOP. Participants also indicated increased participation in other science in-services as promoted by their individual interest. As a result of MOP in-services, 54.1% of respondents attend other science in-services of their choice (see Table 5).

It was consistent throughout the study that the MOP respondents felt the in-services had been effective in several key areas as characterized in the literature (Joyce & Showers, 1980; Lawrence, 1974;
Table 5
Perceived Professional Changes

<table>
<thead>
<tr>
<th>Perceived change</th>
<th>MOP participants</th>
<th>Non-MOP participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Attend other science in-services, promoted by my interest</td>
<td>20</td>
<td>54.1</td>
</tr>
<tr>
<td>Attend professional meetings such as MSTA</td>
<td>3</td>
<td>8.1</td>
</tr>
<tr>
<td>Read more science magazines such as Science and Children</td>
<td>7</td>
<td>18.9</td>
</tr>
<tr>
<td>Have become more involved in improving my school’s science curriculum</td>
<td>12</td>
<td>32.4</td>
</tr>
<tr>
<td>Plan and teach science differently</td>
<td>24</td>
<td>64.9</td>
</tr>
</tbody>
</table>

McLaughlin & Berman, 1977). Those areas included concrete, teacher-specific, extended training (not "one shot") with opportunity for supervised practice and continuous modeling of concepts and practices by the in-service presenters. Joyce and Showers (1980) concluded from their analysis of 200 research reports that effective in-service programs include five elements essential for success. Those components were: (1) clear presentation of theory behind approach modeled, (2) modeling of effective teaching, (3) practice in simulated and classroom settings, (4) structured and open-ended feedback, and (5) coaching for application.

The responses given by MOP participants are consistent with the guidelines revealed in the literature for effective in-services. Based on
the responses given by both teachers and principals, the perception is that MOP has a positive impact on the teaching of physical science in the elementary classroom.

Instructional Strategies

Did the instructional strategies of teachers change after participation in Michigan Operation Physics in-services as perceived by both the teachers and principals?

Based on survey responses, perceived instructional strategies of teachers did change as a result of participation in Michigan Operation Physics. First, it is important to focus on the instructional strategies modeled in the MOP in-service. To be most effective, training should include theory, modeling of effective teaching strategies, practice, feedback, and classroom application with coaching (Joyce & Showers, 1980).

Of the participants of MOP in-services, 97.3% of those responding to the survey questions indicated hands-on, inquiry-based science instruction was modeled as a teaching strategy. As a result of their experiences, 69.4% of MOP participants indicated, upon returning to the classroom, increased students' opportunities for learning science through hands-on, inquiry-based instruction. It should be noted that teachers' attitudes about the teaching of science and their understanding of science concepts were impacted positively by this experience (see Table 6).

MOP participants were asked to rank order how often they felt they used a particular instructional strategy in teaching science before and after the MOP in-service experiences. Table 7 gives the mean rank
and standard deviation of teaching strategies used in science classes by MOP participants before participating in MOP in-services.

Table 6
Perceived Impact of MOP In-Services on the Classroom

<table>
<thead>
<tr>
<th>Impact</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased student opportunities for hands-on science</td>
<td>25</td>
<td>67.6</td>
</tr>
<tr>
<td>Increased your understanding of science concepts</td>
<td>28</td>
<td>75.7</td>
</tr>
<tr>
<td>Increased your teaching of science concepts</td>
<td>20</td>
<td>54.1</td>
</tr>
<tr>
<td>Changed your attitude toward science</td>
<td>8</td>
<td>21.6</td>
</tr>
</tbody>
</table>

Note. Respondents could check more than one answer. Number of MOP respondents = 37.

Table 7
Mean Ranking of Teaching Strategies Used in Science Classes Before MOP In-Service Training

<table>
<thead>
<tr>
<th>Rank</th>
<th>Strategy used</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Demonstration</td>
<td>2.94</td>
<td>1.41</td>
</tr>
<tr>
<td>2</td>
<td>Lecture/discussion</td>
<td>2.94</td>
<td>2.20</td>
</tr>
<tr>
<td>3</td>
<td>Hands-on</td>
<td>3.11</td>
<td>2.00</td>
</tr>
<tr>
<td>4</td>
<td>Projects</td>
<td>3.75</td>
<td>1.56</td>
</tr>
<tr>
<td>5</td>
<td>Small group learning</td>
<td>3.88</td>
<td>1.61</td>
</tr>
<tr>
<td>6</td>
<td>Film/video</td>
<td>5.09</td>
<td>1.69</td>
</tr>
<tr>
<td>7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Learning center</td>
<td>5.64</td>
<td>1.76</td>
</tr>
</tbody>
</table>

<sup>a</sup>Rank 1 = most frequently used instructional strategy.  
<sup>b</sup>Rank 7 = least frequently used instructional strategy.
Lecture/discussion was perceived by 47.2% of MOP respondents as the instructional strategy used most frequently in the classroom. Hands-on, student investigation was perceived by 28.6% of MOP respondents as the instructional strategy used most frequently in the classroom before participation in Operation Physics. However, after having participated in MOP, 43.8% of the respondents indicated hands-on, student investigation was the most frequently used strategy, while 25% of the respondents perceived lecture/demonstration as the instructional strategy used most frequently in the elementary classroom (see Table 8).

Table 8
Mean Ranking of Teaching Strategies Used in Science Classes After MOP In-Service Training

<table>
<thead>
<tr>
<th>Rank</th>
<th>Strategy used</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>Hands-on</td>
<td>2.06</td>
<td>2.00</td>
</tr>
<tr>
<td>2</td>
<td>Demonstration</td>
<td>2.91</td>
<td>1.53</td>
</tr>
<tr>
<td>3</td>
<td>Projects</td>
<td>3.22</td>
<td>1.56</td>
</tr>
<tr>
<td>4</td>
<td>Lecture/discussion</td>
<td>3.63</td>
<td>2.15</td>
</tr>
<tr>
<td>5</td>
<td>Small group learning</td>
<td>3.69</td>
<td>1.60</td>
</tr>
<tr>
<td>6</td>
<td>Learning center</td>
<td>5.63</td>
<td>1.75</td>
</tr>
<tr>
<td>7b</td>
<td>Film/video</td>
<td>5.69</td>
<td>1.20</td>
</tr>
</tbody>
</table>

aRank 1 = most frequently used instructional strategy. bRank 7 = least frequently used instructional strategy.
Michigan Operation Physics participants and non-Operation Physics participants who participated in some type of training during the last 3 years were similar prior to training in that both groups ranked demonstration as the Number 1 teaching strategy used in the science classroom. After training for both groups, MOP participants listed hands-on, demonstration, project, and lecture/demonstration as the rank order for preferred teaching strategies. Clearly, MOP participants changed their teaching strategy to a more hands-on, inquiry based instruction, thus reflecting a clearer understanding of the processes of science.

In contrast, non-MOP participants, after participation in science in-services, still ranked demonstration as the Number 1 teaching strategy (see Table 9). Their rank order of teaching strategies represents less opportunity for student participation than that of MOP participants.

When teachers and principals were asked to rank how often they believed teachers used a particular instructional strategy in teaching science before and after participation in MOP, lecture/discussion and demonstration ranked Number 1 simultaneously by both groups, while hands-on, student investigation ranked Number 3; however, after participation in MOP hands-on, student investigation was ranked Number 1 by both teachers and principals (see Table 10).

The results clearly indicate MOP participants and their principals ranked hands-on, inquiry based instruction as more important as a teaching strategy after Operation Physics training than prior to that training. It should be kept in mind, however, the non-MOP sample size is too small to make any definitive statement. The principals' perception does support MOP perception of the positive impact of Operation Physics
Table 9
Mean Ranking of Teaching Strategies Used in Science Classes After Non-MOP Participation in In-Service Training

<table>
<thead>
<tr>
<th>Before training</th>
<th>After training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rank</td>
<td>Rank</td>
</tr>
<tr>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>-------</td>
<td>----</td>
</tr>
<tr>
<td>1.60</td>
<td>0.89</td>
</tr>
<tr>
<td>2.40</td>
<td>0.55</td>
</tr>
<tr>
<td>3.40</td>
<td>1.52</td>
</tr>
<tr>
<td>3.60</td>
<td>2.41</td>
</tr>
<tr>
<td>4.80</td>
<td>1.64</td>
</tr>
<tr>
<td>6.40</td>
<td>0.89</td>
</tr>
<tr>
<td>6.80</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Note. Number of MOP participants = 5.  
*aRank 1 = most frequently used instructional strategy. bRank 7 = least frequently used instructional strategy.

When MOP participants were asked if they shared with colleagues teaching strategies learned from MOP in-services, 68.8% responded yes. The overwhelming method used by teachers was informal sharing. Little's (1981) study of the effect of staff development found where staff development had the greatest impact on teaching, teachers shared their ideas about instruction and tried new techniques in the classroom.
Table 10

Rank Comparison of Instructional Strategies Used to Teach Science as Perceived by Principals and Teachers After Participation in MOP

<table>
<thead>
<tr>
<th>Rank of principals</th>
<th>Strategies</th>
<th>Rank of teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>Hands-on</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Demonstration</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Projects</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Small group learning</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>Lecture/discussion</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>Learning center</td>
<td>6</td>
</tr>
<tr>
<td>7b</td>
<td>Film/video</td>
<td>7</td>
</tr>
</tbody>
</table>

aRank 1 = most frequently used instructional strategy. bRank 7 = least frequently used instructional strategy.

A critical issue at the elementary level related to the teaching of hands-on, inquiry based science is time. As a result of the science inservices, 83.8% of MOP respondents indicated their science classes have become more hands-on, inquiry based. However, only 47.2% of those same teachers have increased the amount of time they spend teaching science. Of those indicating no change, 35.1% cited lack of time as the major reason with inadequate room facility and lack of materials and equipment cited by 10.8% and 8.1%, respectively.

The actual minutes spent teaching per science lesson by both groups were comparable with 75% of MOP participants and 64% of non-MOP participants spending 30 or more minutes per lesson (see
Table 11). However, in contrast, 41.7% of MOP participants compared to 18.2% of non-MOP participants spend more than 40 minutes per science lesson. When asked to specify the amount of time spent teaching science, 33.4% of MOP participants indicated teaching science every day compared to 27.3% of non-MOP participants. Those teaching science every other day were 28.6% and 36.4% for MOP and non-MOP participants, respectively.

Table 11
Minutes Spent Per Science Lesson

<table>
<thead>
<tr>
<th>Time</th>
<th>MOP</th>
<th>Non-MOP</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-20 minutes</td>
<td>2.8%</td>
<td>36.4%</td>
</tr>
<tr>
<td>20-30 minutes</td>
<td>19.4%</td>
<td>0.0%</td>
</tr>
<tr>
<td>30-40 minutes</td>
<td>33.3%</td>
<td>45.5%</td>
</tr>
<tr>
<td>More than 40 minutes</td>
<td>41.7%</td>
<td>18.2%</td>
</tr>
<tr>
<td>Less than 15 minutes</td>
<td>2.8%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Note. Number of MOP respondents = 37. Number of non-MOP respondents = 11.

It has been suggested by Manning et al., (1982) that surveying principals for time spent in instruction is unreliable due in part to the fact that principals do not know what takes place in the classroom consistently. This is consistent with the fact that 54.5% of principals have observed 50% or less of their staff teaching science. However, of those principals surveyed, 90.9% felt science should be taught everyday for a period of 20 to 40 minutes.
A crucial responsibility of principals is that of observing their teaching staff in the classroom. During the 1992-93 school year, 54.6% of the principals participating in this study had observed at least 50% of their staff teaching science during that period (see Table 12).

Table 12
Percentage of Teachers Observed by Principal Teaching Science

<table>
<thead>
<tr>
<th>Portion of staff observed</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1% to 25%</td>
<td>2</td>
<td>18.2</td>
</tr>
<tr>
<td>26% to 50%</td>
<td>4</td>
<td>36.4</td>
</tr>
<tr>
<td>51% to 75%</td>
<td>2</td>
<td>18.2</td>
</tr>
<tr>
<td>76% to 100%</td>
<td>3</td>
<td>27.1</td>
</tr>
<tr>
<td>None</td>
<td>0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

To further analyze the lack of time spent teaching science in the elementary classroom, principals were asked to rank order nine factors that have been identified as reasons why teachers do not teach science (Coble & Rice, 1982). Three principals (27.3%) chose not to rank the items (see Table 13).

However, the inability to improvise for supplies and equipment was ranked by principals as the Number 1 reason why teachers do not teach science, ranking inadequate room facility as Number 2. Principals (81.2%) ranked reading as the most important subject to be taught at the elementary level. In comparison, this finding was consistent with
Table 13

Mean Rank of Factors Affecting the Teaching of Science as Perceived by the Principal

<table>
<thead>
<tr>
<th>Rank</th>
<th>Factor</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Inability to improvise materials and equipment</td>
<td>3.38</td>
<td>1.19</td>
</tr>
<tr>
<td>2</td>
<td>Inadequate room facility</td>
<td>3.71</td>
<td>3.04</td>
</tr>
<tr>
<td>3</td>
<td>Lack of understanding of methods of teaching science</td>
<td>3.88</td>
<td>2.70</td>
</tr>
<tr>
<td>4</td>
<td>Insufficient understanding of science concepts</td>
<td>4.00</td>
<td>2.83</td>
</tr>
<tr>
<td>5</td>
<td>Lack of supplies and equipment</td>
<td>4.25</td>
<td>1.98</td>
</tr>
<tr>
<td>6</td>
<td>Emphasis on reading and math</td>
<td>5.00</td>
<td>2.14</td>
</tr>
<tr>
<td>7</td>
<td>Insufficient time to teach science</td>
<td>5.57</td>
<td>2.99</td>
</tr>
<tr>
<td>8</td>
<td>Insufficient funds</td>
<td>7.14</td>
<td>2.04</td>
</tr>
<tr>
<td>9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Inappropriate textbook</td>
<td>7.29</td>
<td>1.50</td>
</tr>
</tbody>
</table>

<sup>a</sup>Rank 1 = most likely to prevent science from being taught.  
<sup>b</sup>Rank 9 = least likely to prevent science from being taught.

the perception of teachers. However, with few inconsistencies, the perception of both principals and teachers is that participation in MOP resulted in more hands-on, inquiry based instruction in the elementary science classroom.

Perceived Conceptual Understanding

Did teachers' conceptual understanding of physical science improve after participation in Michigan Operation Physics as perceived by
both teacher and principal?

The perceptions of both teachers and principals were positive. Based on responses given by teachers and principals, the perception was that Michigan Operation Physics did improve teachers' conceptual understanding of physics (see Table 14). Further analysis of responses reveals that 54% of those teachers surveyed increased their teaching of science concepts because of participation in MOP. The increase in teaching of science concepts paralleled the fact that 73% of teachers felt they became more knowledgeable about science concepts, while 46% gained skills necessary to teach science.

"Confident" or "moderately comfortable with physical science concepts" was the response of 72.8% of principals (see Table 14) regarding MOP participants' conceptual understanding of physical science. This compares favorably to the same perception held by 85.7% of MOP and 80% of non-MOP respondents. However, 9.1% indicated they were not sure about their teachers' conceptual understanding of physical science. Those same principals (63.6%) felt teachers participating in Michigan Operation Physics were more enthused about the teaching of science.

It is necessary to provide teachers with training in science so that they acquire the knowledge and skills that will enable them to provide quality instruction in the classroom. Findings suggest that Michigan Operation Physics is a model that has incorporated several of the elements of effective in-service practices. However, with the many paradigm shifts in education, one must take into account the length of time required to change. McLaughlin and Marsh (1979) warned it takes
Table 14  
Comparison of Principals' and Teachers' Perceptions of  
Teachers' Conceptual Understanding of  
Physical Science Concepts

<table>
<thead>
<tr>
<th>Teacher Perception</th>
<th>Teacher non-MOP valid %</th>
<th>Teacher (MOP) valid %</th>
<th>Principal valid %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confident with physical science</td>
<td>25.7</td>
<td></td>
<td>27.3</td>
</tr>
<tr>
<td>Moderately confident with physical science concepts</td>
<td>80.0</td>
<td>60.0</td>
<td>45.5</td>
</tr>
<tr>
<td>Not confident with physical science concepts</td>
<td>20.0</td>
<td>8.6</td>
<td>0.0</td>
</tr>
<tr>
<td>Not sure about MOP teachers' conceptual understanding of physical science</td>
<td>5.7</td>
<td></td>
<td>9.1</td>
</tr>
</tbody>
</table>

Note. Principal valid percentage = 9 cases, 2 cases missing.

several years for teachers to initiate and become comfortable and effective using a new technique, skill, or concept they have learned in in-service programs so that the impact is seen in the classroom.

The perceptions of both the principals and teachers who are participants in MOP are consistent regarding the teachers' understanding of physical science concepts.

Perceived Administrative Support

Are there differences in perceptions of the principal's support of elementary science as perceived by Michigan Operation Physics participants, non-Michigan Operation Physics participants, and the principals of those teachers?
The school principal may be seen as an innovator, an instructional leader, or a strong supporter in the supervision of the elementary science program. A fourth research question was concerned with the identification of the perceived role of the principal in promoting the science curriculum. The discussion describes the findings and their implications in relation to the principals' leadership role in the science curriculum, instruction, in-service education, and the financial resources and responsibilities.

In Mechling and Oliver's (1982) handbook of the principal's role in elementary school science, principals are urged to take a leadership role and be an advocate for science. Principals can communicate their viewpoints to teachers through principal-teacher discussions, classroom visitations, and other as noted in Table 15.

When teachers were asked how their principal demonstrates leadership in science the top response by 27.0% of MOP respondents was "visiting classrooms" when science lessons are being taught, with 24.3% indicating the "organization of public expositions of students' work" followed by the "discussion of science with teachers." In contrast (see Table 15), the principal's perception of how leadership is demonstrated is not consistent with that of teachers. One hundred percent of principals cited "visit classroom when science lesson is being taught" as the Number 1 method of demonstrating leadership as compared to 27.0% of MOP participants and 36.4% of non-MOP participants. Over 50% of principals compared to 10.8% of MOP participants and 9.1% of non-MOP participants stated "insisting that science be taught for a specified amount of time" is a priority. There was little
<table>
<thead>
<tr>
<th>Principals</th>
<th>Perception</th>
<th>MOP Teachers</th>
<th>Non-MOP Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>90.9%</td>
<td>Discuss science with teachers</td>
<td>21.6%</td>
<td>54.5%</td>
</tr>
<tr>
<td>100.0%</td>
<td>Visit classroom when science lesson is being taught</td>
<td>27.0%</td>
<td>36.4%</td>
</tr>
<tr>
<td>27.3%</td>
<td>Sharing science success stories as a model</td>
<td>16.2%</td>
<td>27.3%</td>
</tr>
<tr>
<td>9.1%</td>
<td>Devoting PTO meetings to science</td>
<td>10.8%</td>
<td>18.2%</td>
</tr>
<tr>
<td>18.2%</td>
<td>Mounting a publicity campaign for science</td>
<td>2.7%</td>
<td>9.1%</td>
</tr>
<tr>
<td>54.5%</td>
<td>Organizing public exposition of students' work</td>
<td>24.3%</td>
<td>27.3%</td>
</tr>
<tr>
<td>54.5%</td>
<td>Identifying community resources</td>
<td>10.8%</td>
<td>18.2%</td>
</tr>
<tr>
<td>63.6%</td>
<td>Insisting that science be taught a specified amount of time</td>
<td>10.8%</td>
<td>9.1%</td>
</tr>
<tr>
<td>0.0%</td>
<td>Assisting colleges and universities to improve teacher preparation programs in science</td>
<td>2.7%</td>
<td>9.1%</td>
</tr>
<tr>
<td>0.0%</td>
<td>None of the above</td>
<td>35.1%</td>
<td>27.3%</td>
</tr>
</tbody>
</table>

consistency of perceptions among teachers and principals.

Recent studies by the U.S. Department of Education consistently indicated students are more likely to be successful where principals felt strongly about instruction and clearly articulated those viewpoints to teachers.
According to Mechling and Oliver (1982), the principal must play a key role in science in-service education of their teachers. When asked how principals contribute to the science in-service of teaching staff, 35.1% of MOP respondents perceived the most emphasis is placed on providing training when new science curriculum is adopted or developed (see Table 16). When principals were asked the same question, 63.6% indicated active participation in in-service programs compared to the same response by 21.6% of MOP participants and 9.1% of other teachers.

Table 16
Teachers' and Principals' Perceptions of How Principal Contributes to In-Service

<table>
<thead>
<tr>
<th>Principals Percentage</th>
<th>Contribution</th>
<th>MOP Teachers</th>
<th>Non-MOP Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>54.5%</td>
<td>Designing programs to pump new life into old science curricula</td>
<td>18.9%</td>
<td>9.1%</td>
</tr>
<tr>
<td>27.3%</td>
<td>In-service for the adoption of new curricula</td>
<td>35.1%</td>
<td>27.3%</td>
</tr>
<tr>
<td>9.1%</td>
<td>In-service for credit</td>
<td>14.3%</td>
<td>0.0%</td>
</tr>
<tr>
<td>63.3%</td>
<td>Participating in in-service programs</td>
<td>21.6%</td>
<td>9.1%</td>
</tr>
</tbody>
</table>

Note. Respondents could check more than one answer.

When asked if a science in-service or staff development program had been provided within the school year, 54.5% of principals surveyed indicated yes. Principals who sponsored science in-service programs were asked to indicate who planned the most recent of the in-service
program. According to the survey findings, science or other supervisory personnel ranked Number 1 in the planning of the in-service program.

It was significant that only 9.1% of the principals who had provided an in-service program also attended a science in-service with their staff. However, 30% of the responding principals had attended at least one MOP workshop with their teachers. The teachers' perception of the contributions made to staff development by the principal was not consistent with that of principals (see Table 16).

Several studies support a participatory role by the principal (Blome & James, 1985; Mangieri & Arnn, 1986; Orlich, 1985; Ornstein & Hunkins, 1988) if implementation of innovative elementary science curricula is to be successful.

Over 80% of the principals indicated local funds for the support of the school's science program. More than 50% of the principals had funds for field trips, release time for teachers to attend state science meetings, and to provide in-service for teachers. However, only 13% of MOP participants felt funds were used to promote or provide science in-service for teachers. Principals are not articulating their support to teachers. Stallings and Mohlman (1981) found that teachers improve most in schools where the principal was supportive and clearly and consistently communicated that support and school policies.

The data consistently supported differences in the perception of the principal's support of elementary science as viewed by MOP participants and the principals of those participants. Often times the principals' view of themselves was much more supportive than that perceived by the teacher.
Summary

In this chapter, data have been analyzed in a narrative description supplemented by tables. The purpose of this study was to determine the impact of Michigan Operation Physics training on the teaching and learning of basic physics concepts, as perceived by both the teachers and the principals of those teachers who participated in Michigan Operation Physics. Based on the findings of the study, several strategies incorporated in the Operation Physics staff development program emerged that are consistent with literature studies of effective staff development programs.

A total of 37 Michigan Operation Physics participants, 11 non-Michigan Operation Physics participants, and 11 principals from southwestern Michigan responded to the questionnaire. There were four research questions answered by the study:

1. Did both Michigan Operation Physics participants and non-Operation Physics participants perceive the science in-services attended to be effective?

2. Did the instructional strategies of teachers change after participation in Michigan Operation Physics in-services as perceived by both the teachers and principals?

3. Did teachers' conceptual understanding of physical sciences improve after participation in Michigan Operation Physics as perceived by both teacher and principal?

4. Are there differences in perceptions of the principal's support of elementary science as perceived by Michigan Operation Physics participants?
participants, non-Michigan Operation Physics participants, and the principals of those teachers?

The findings of this study indicate that MOP participants perceived their training in Michigan Operation Physics in-services to be effective in the areas of delivery and modeling of teaching and learning practices. Although responses differ between MOP respondents and non-MOP respondents of specific characteristics of in-services attended, there is notable similarity in MOP respondents' and non-MOP respondents' perceptions of their ability to transfer the skills and knowledge attained in the in-services to the classroom.

When comparing instructional changes before and after participation in Michigan Operation Physics training, MOP participants perceived changes in classroom instructional strategies. Participants indicated increasing student opportunities for learning science through hands-on, inquiry based instruction. In contrast, non-MOP participants' showed little change in their perception of instructional strategies used in the classroom after participation in in-services.

Both MOP participants and principals perceived improved conceptual understanding of physics concepts after participation in Michigan Operation Physics. The majority of teachers and principals were confident or moderately confident with teachers' conceptual understanding of physical science. However, the ability of teachers to effectively deliver science in the classroom, as viewed by both teachers and principals, saw little improvement.

There was little consistency among teachers and principals regarding the principal's leadership role in supporting science at the elementary
level. Principals perceived themselves as supportive of science. In contrast, MOP participants and non-MOP participants do not perceive principals as supportive of elementary science.

Analysis of data was limited to frequency distribution and the application of the appropriate summary statistics. A variety of uncontrolled factors may have affected the results. The small group sizes were a major concern. The size of each group coupled with the low return rate may have interfered with the validity of the study and limits the generalizability of the results.
CHAPTER V

CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Organization of the Chapter/Synopsis

During the past 20 years, it has been known as staff development, in-service education, professional development, and human resource development. Despite the name used, too often educators (usually teachers) sat passively while "experts" exposed them to new ideas or "trained" them in new practices. "Result-driven education, system thinking, and constructivism are producing profound changes in how staff development is conceived and implemented" (D. Sparks, 1994, p. 26).

D. Sparks (1994) conceived that if constructivism is to drive science teaching and learning, rather than teachers receiving knowledge from experts in training sessions, teachers and administrators must make sense of the teaching and learning process in their own context. Constructivist teaching must be learned through constructivist staff development. Teachers must collaborate with peers, researchers, and their own students to make sense of the teaching and learning process.

New initiatives have begun in the state of Michigan to improve science education through constructivist teaching and learning. Michigan Operation Physics (MOP) is one of those initiatives providing staff development to elementary teachers to improve science education. Therefore, the research questions asked are timely:
1. Did both Michigan Operation Physics participants and non-Operation Physics participants perceive the science in-services attended to be effective?

2. Did the instructional strategies of teachers change after participation in Michigan Operation Physics as perceived by both the teacher and the principal?

3. Did teachers' conceptual understanding of physical science improve after participation in Michigan Operation Physics as perceived by both teacher and principal?

4. Are there differences in perceptions of the principal's support of elementary science as perceived by Michigan Operation Physics and non-Operation Physics participants and the principals of those teachers?

The purpose of this study was to determine the impact of MOP on the teaching and learning of basic physics concepts, as perceived by both the teachers and the principals of those teachers who participated in Michigan Operation Physics. Areas of impact that were examined and analyzed were the teacher's instructional strategies, the teacher's conceptual knowledge and understanding of physical science, attitudes toward the teaching and learning of science, and perceived support provided by the principal. Aspects of the principal's role that were examined and analyzed were the science instructional program, science budget, in-service education, and teacher observation.

Questionnaires were mailed to 77 Michigan Operation Physics participants, 33 non-Operation Physics participants, and 16 principals. Of the returned instruments, 59 were coded and analyzed.
Conclusions

The purpose of this study was to determine the impact of Michigan Operation Physics training on the teaching and learning of basic physics concepts, as perceived by both the teachers and the principals of those teachers who participated in Michigan Operation Physics.

The impact of MOP training is delineated through four research questions:

1. Did both Michigan Operation Physics participants and non-Michigan Operation Physics participants perceive the science in-services attended to be effective?

2. Did the instructional strategy of teachers change after participation in Michigan Operation Physics in-services as perceived by both teachers and principals?

3. Did teachers' conceptual understanding of physical science improve after participation in Michigan Operation Physics as perceived by both teachers and principals?

4. Are there differences in perceptions of the principals' support of elementary sciences as perceived by Michigan Operation Physics participants and the non-Michigan Operation Physics participants and the principals of those teachers?

The limited scope of this study precludes the adoption of any definitive position. The in-services were perceived effective by Michigan Operation Physics participants. However, the findings are inconsistent for MOP participants; that is, although they maintain an enhanced perception of their skills and knowledge of physical science, the MOP
respondents lack confidence in their ability to present science in the classroom.

The findings of this study imply a change in instructional strategies as perceived by both the teachers and the principals. MOP respondents perceived their teaching strategies shifted from lecture/demonstration to more hands-on, inquiry based instruction after participation in Michigan Operation Physics. However, according to McLaughlin and Marsh (1979), it takes one to several years for teachers to initiate and become comfortable and effective using a new skill, technique, or content they have learned in in-service programs. Because there was no indication of time lapse between MOP training and this study, the results may be misleading.

The MOP participants, despite positive perceptions of their skills as a result of the MOP in-service, did not exhibit congruent perceptions of enhanced attitudes toward science and strategies to gain support for the teaching of science. In contrast, non-MOP participants were decisively less positive in their perception of their ability and knowledge but held significantly more enhanced attitudes toward science and strategies to gain support for the teaching of science. However, because of the small number of non-MOP respondents who had participated in science in-services during the last 3 years, the validity of the conclusion is questionable.

The findings of this study indicated the teachers and principals do view the principal's role differently. There is a lack of congruence between teachers and principals as it relates to the principal's role and support of elementary science. Principals' perceptions were consistent
in regards to their support of elementary science. Principals perceived they consistently demonstrated leadership in science education. In contrast both MOP respondents and non-MOP respondents perceived the principal's role as nonsupportive of elementary science.

MOP in-service participants perceived their science skills and knowledge as positively impacted by the in-services. Their lack of comparable perception in their ability to demonstrate that in the classroom is supported by the research. Given their participation in the MOP in-services and their perception of the in-service as a continuous process, the probability, over time, that their perception of their ability to transfer skills and knowledge attained in the in-services may be more consistent with their perceived skills and knowledge attained.

Implications of the Study

The intent of this study was to determine the teachers' and principals' impact of Michigan Operation Physics on the teaching of physics concepts in the elementary classroom. Inherent problems with population size, time of study, and response rate contributed to the researcher's inability to be conclusive about the findings from this study. The findings from this study also leaves a void of evidence that could have shown the effectiveness of MOP and the relation, if any, between variables. Because of the extreme difficulty in controlling all the factors at work when determining one's perceptions, attempting to determine whether MOP training was the only contributor to the perceived changes in attitudes, instructional strategies, and conceptual understanding of physics concepts may prove equally difficult. As literature was
reviewed, a definite need to study the impact of science in-services emerged.

While no definitive statement can be made from this study, a continued effort must be made by researchers to determine the perceived impact of Michigan Operation Physics training on the teaching and learning of physics concepts in the classroom.

Recommendations for Further Research

A long-term study that researches attitudinal changes may be able to track the stages of development of these changes more clearly. Three appropriate stages might be pre-Michigan Operation Physics training, after a well defined period of time within 6 months of Michigan Operation Physics training, and after at least 1 to 3 years of teaching science after receiving Michigan Operation Physics training.

In order to measure the impact of MOP training on the teaching and learning of physics concepts in the classroom, future research may attempt to discern the various components of effective in-service training or combinations of which evoke the broadest knowledge and skills development. Knowledge and skills are observable phenomenons and less difficult to measure than attitudes.

In the process of determining the perceptions of changes, the researcher created an instrument that reflects those perceptions not the realities. Another researcher could delve into the perceptions of effective in-services and related changes and define the areas of impact more clearly.
If the study undertaken here were to be replicated and if more definitive conclusive results are desired, the following changes are suggested:

1. Increase the sample population by including all elementary teachers who have been trained in Michigan Operation Physics within a given period of time in the random selection process.
2. Administer the instrument to the selected population in the fall of the school year as opposed to late spring.
3. Increase the sample population of teachers who have not received Michigan Operation Physics training.
4. Use a statistical analysis that would allow the researcher to explore the relation between the variables of the study and summarize the relations shown with a test of statistical significance.
5. Create a more definitive document that delineates perceptions in the areas sought.
6. Use a more structured attempt to receive responses and to determine the reasons for nonresponse.

Summary

In Chapter V the results of the study were examined. These results were intended to delineate the perceived impact of Michigan Operation Physics on the teaching and learning of physics concepts in the elementary classroom. While inclusive, information consistent with the literature has been obtained. Through a continued accumulation of data, a more thorough understanding of the impact of Operation Physics will happen. More questions are offered for future researchers. Much
more needs to be accomplished if the full impact of Michigan Operation Physics is to be determined.
Appendix A

Map of Accessible Population
Location & Distribution of Existing Teams

1) Ann Arbor (Washtenaw)
2) Coldwater (Branch/Calhoun)
3) Lansing (Ingham/Clinton)
4) Flint (Genessee)
5) Kalamazoo (Barry/Kalamazoo)
6) Lansing (Ingham/Eaton)
7) Marquette (Marquette/Alger)
8) Detroit Area (Macomb)
9) Big Rapids (Mecosta/Osceola)
10) Traverse City (Grand Traverse/LeeAnnau)
11) Pontiac (Oakland/Livingston)

Michigan OPERATION PHYSICS
1989-90 Teams'
Appendix B
Letter of Intent to Operation Physics Team Members
January 28, 1993

Dr. David Housel  
Oakland Intermediate School District  
2100 Pontiac Lake Road  
Waterford, Michigan 48328

Dear Dave:

This note is to confirm our telephone conversation of this week regarding our need for your assistance in identifying school buildings with multiple teachers who have experienced more than one OPERATION PHYSICS workshop. Our desire is to identify one or two schools in your area that fit the above criteria and then assess the impact of the MOP training in the classroom. The study would involve minimal time from school personnel and be on a voluntary basis. Your help is needed to identify schools that qualify and then Ms. Brenda Earhart will contact them and ask for their assistance.

Brenda will contact you within the next week or two, but I first wanted to introduce her to you and provide an address and telephone number should you want to contact her.

Ms. Brenda Earhart  
Kalamazoo Area Mathematics and Science Center  
600 West Vine Street  
Kalamazoo, Michigan 49008  
Telephone: (616) 337-0004

Thank you for your willingness to assist us and I look forward to sharing the results of her analysis with you in the future.

Sincerely,

Robert H. Poel, Director  
Center for Science Education  
Michigan OPERATION PHYSICS
Appendix C

Letter to Principals Requesting Names of Non-Operation Physics Teachers
April 15, 1993

Dear Principal:

I am a doctoral student at Western Michigan University in the Department of Educational Leadership. I am also employed at the Kalamazoo Area Mathematics and Science Center. I would like your assistance in completing my research.

I am conducting a research project to determine teachers' and principals' perception of the impact of OPERATION PHYSICS in-service programs on the teaching of elementary science AND your perception of the principal's role in elementary school science. As a part of my research it is necessary for me to survey three or four teachers from your school who have not participated in OPERATION PHYSICS in-service programs in addition to those teachers who have participated in OPERATION PHYSICS in-service programs.

Please provide me with a list of your regular education teaching staff, grades one through six, by April 23, 1993. My fax number is (616) 337-0049. I will randomly select three or four teachers from the list who have not participated in OPERATION PHYSICS in-service programs to voluntarily participate in my study. I can assure you that all questionnaire responses will be held in strictest confidence.

I will also seek your response to a questionnaire in the same study. You should receive your survey the first week in May. Your cooperation and participation in this study is appreciated. I will follow up with a phone call in a few days.

Sincerely,

Brenda P. Earhart
Kellogg Project Coordinator
(WMU Doctorial Candidate)
Appendix D

Teacher Survey and Cover Letter
(Michigan Operation Physics)
Dear Teacher:

I am a doctoral student at Western Michigan University in the Department of Educational Leadership. I am also employed at the Kalamazoo Area Mathematics and Science Center. I would like your assistance in completing my research.

I am conducting a research project to determine teacher's perception of the impact of OPERATION PHYSICS (OP) on the teaching of elementary science. As a teacher who has participated in one or more OP inservices your responses to the items on the enclosed questionnaire will be helpful in determining the areas in which OP has had the greatest impact.

To parallel the movement for reform in science education, the State of Michigan has established New Directions and Goals in Science Education. As our society demands scientific literacy for all students, the need to prepare our teachers for this challenge becomes more demanding. School districts, colleges, and universities across the state are taking on the challenge. OPERATION PHYSICS, one of many in the state of Michigan, is a major effort to improve the teaching and learning of physics concepts in the upper elementary and middle schools.

The purpose of this study is to investigate the teacher's perception of the impact of MOP on the teaching of elementary science. The survey is being administered to teachers and principals in several school districts.

Your cooperation and participation in this study is appreciated. I can assure you that all questionnaire responses will be held in the strictest confidence. The code number you may notice on the questionnaire will be used only to determine those who have not responded after a period of time so that follow-up mailings to encourage response need not be sent to the entire group.

Your responses are very important. Please take the time to complete the questionnaire and return it by May 12, 1993. I thank you in advance for your valuable assistance and prompt reply.

Sincerely,

Brenda P. Earhart
Kellogg Project Coordinator
( WMU Doctoral Candidate )
Teacher Survey
Please read CAREFULLY and respond to ALL questions regarding your participation in Operation Physics in-service program. If a question has more than one possible answer, please ✓ all choices that apply. Note that several questions require you to RANK ORDER your response. When completed, return to me as soon as possible in the enclosed self-addressed envelope.

Professional Background
1. What was your undergraduate degree major? __________________________

2. Highest degree earned
   ☐ Bachelor's
   ☐ Master's
   ☐ Doctorate
   ☐ Other

3. Total experience as an elementary school teacher?
   ☐ 0 to 5 years
   ☐ 6 to 10 years
   ☐ 11 to 15 years
   ☐ 16 to 20 years
   ☐ 21 to 25 years
   ☐ 26 or more

4. What grade level are you presently teaching? ________

5. Approximate number of students per class?
   ☐ 20
   ☐ 25
   ☐ 30
   ☐ 35
   ☐ Greater

6. Description of participation in science inservice
   ☐ Voluntary
   ☐ Mandatory

7. Major teaching responsibility
   ☐ Self-contained
   ☐ Science consultant
   ☐ Science teacher
   ☐ Other (explain) __________________________

8. Approximately how many hours of Operation Physics training have you had? ________

Effectiveness of science inservice
Please complete this survey based on your experiences from participation in one or more Operation Physics inservices during the last three years.

9. Please describe the inservice
   ☐ Hands-on
   ☐ Lecture/discussion
   ☐ Demonstration
   ☐ Other, specify __________________________
10. Did the inservice increase your interest in the teaching of science?

☐ Yes
☐ No

11. Which of the Operation Physics concept/content area inservice have you participated in? (please check all that apply).

☐ Magnets & Magnetism
☐ Energy
☐ Heat
☐ Simple Machines
☐ Forces & Motion
☐ Electricity
☐ Astronomy
☐ Matter & Its Changes
☐ Forces & Fluids
☐ Measurement
☐ Sound
☐ Color & Vision

12. The in-services were effective.

☐ Yes
☐ No

If yes, check all that apply.

☐ it provided concrete, teacher specific, training
☐ continuous modeling by the in-service presenters
☐ it allowed time for supervised practice
☐ it was not a "one-shot" effort
☐ it provided materials that could be locally developed
☐ it provided time for group and individual interaction while learning
☐ teaching and learning styles applicable to own classroom
☐ thorough, clear presentation of theory behind the approach modeled
☐ other, specify________________________________________________

13. I have shared with my colleagues teaching strategies learned from the Operation Physics inservice(s).

☐ Yes
☐ No

If yes, how? (please check all that apply).

☐ informal sharing
☐ staff meeting
☐ grade level meeting
☐ other, specify________________________________________________

14. What is your perception of the effect of Operation Physics in-service on your attitude about science and the teaching of science?

☐ attitude is more positive
☐ attitude is more negative
☐ attitude is neutral
15. I have found the approach to teaching and learning elementary science, as presented in the Operation Physics in-service, to be useful.  
☐ Yes  
☐ No  

16. Have you found the in-service materials useful in the classroom?  
☐ Yes  
☐ No  

17. The strategies/materials provided in the in-service activities were:  
☐ directly relevant to your curriculum/course.  
☐ adaptable to your curriculum/course.  
☐ appropriate for your curriculum/course.  

18. Were hands-on science activities included in your in-service experience?  
☐ Yes  
☐ No  
If yes, you have:  
☐ increased student opportunities for hands-on science.  
☐ increased your understanding of science concepts.  
☐ increased your teaching of science concepts.  
☐ changed your attitude toward science.  

19. Circle only the items that are true because of your Operation Physics science in-service experience.  
☐ Became more knowledgeable about science concepts.  
☐ Became more knowledgeable about the skills of science.  
☐ Became more aware of the impact of science in society.  
☐ Learned strategies necessary to gain adequate support for teaching science in your school.  
☐ Enhanced your attitude toward science and science teaching.  

20. What is your perception of your conceptual understanding of physical science?  
☐ Confident  
☐ Moderately Confident  
☐ Not Confident  
☐ Not sure how I feel  

**Instructional Strategy**  
21. Please rank how often the following instructional strategies were used in your teaching science before attending the science in-service(s). Rank items (1 = most frequently used strategy; 7 = least frequently used strategy).  
- Demonstration  
- Projects(making things)  
- "Hands-on" student investigations  
- Lecture/Discussion  
- Small group learning  
- Learning centers  
- Film/video
22. Please rank how often you used the instructional strategies since attending the science in-service. Please rank (1 = most frequently used; 7 = least frequently used).

- Demonstration
- Projects (making things)
- "Hands-on" student investigations/experiments
- Lecture/Discussion
- Small group learning
- Learning centers
- Film/Video

23. As a result of the science in-service(s), my science classes have become more hands-on and process oriented.

☐ Yes
☐ No

24. What percentage of science class time do you spend on hands-on science activities?

☐ 20% or less
☐ 21 - 40%
☐ 41 - 60%
☐ 61 - 80%
☐ 81 - 100%

25. As a result of the science in-service(s), the amount of time I spend teaching science in the classroom has increased.

☐ Yes
☐ No

If no, please check all that apply.

☐ insufficient background in science
☐ lack of materials and equipment
☐ inadequate room facilities
☐ lack of time
☐ other, specify ____________________________________________________

26. Specify the amount of time you spend teaching science.

☐ Teach science every day
☐ Teach science every other day
☐ Teach science one a week
☐ Teach science only, all day
☐ Other, specify ____________________________________________________

27. Approximately how many minutes do you spend teaching science per science lesson?

☐ 15 to 20 minutes
☐ 20 to 30 minutes
☐ 30 to 40 minutes
☐ more than 40 minutes
☐ less than 15 minutes
28. Have you had difficulty obtaining the materials needed to teach science?

☐ Yes
☐ No

If yes, check all that apply
☐ Science is not a priority in my school
☐ Lack of funds
☐ Finding materials too time consuming
☐ Other, specify ____________________________

Professional Growth

29. Check the changes you have experienced as a result of the inservice(s).

☐ I attend other science inservices promoted by my interest.
☐ I attend professional meetings such as the MSTA
☐ I read more science magazines such as Science and Children
☐ I have become involved in improving my school’s science curriculum.
☐ I plan and teach science differently

Administrative Support

30. Did you receive administrative support/encouragement for your participation in the inservice activities?

☐ Yes
☐ No

31. Are local school monies or petty cash provided for the following science programs in your school?

☐ Yes
☐ No

If yes, check all that apply.
☐ Science field trips
☐ In-school programs (science fair, science show, etc.)
☐ Release time for teachers to attend state science meetings
☐ Science inservice for teachers
☐ Science supplies (consumables)
☐ Science inservice or staff development.
☐ Other. Specify ____________________________

32. Has your principal attended an Operation Physics workshop with you or other members of the staff?

☐ Yes
☐ No

33. Has your school had a science fair in the last two years?

☐ Yes
☐ No
34. Based upon your observations, rank the importance your principal would assign to the following subjects. Please rank. (1 = Most important subject to teach; 5 = Least important subject to teach)

_____ Math
_____ Physical Education
_____ Reading/Language Art
_____ Science
_____ Social Studies
_____ Other, specify ________________________________

35. Does your principal demonstrate leadership in science by: (check all that apply)

☐ discussing science with their teachers
☐ visiting classroom when science lessons are taught
☐ sharing science success stories as models for teachers to emulate
☐ devoting PTO meetings to science
☐ mounting a publicity campaign for science
☐ organizing public expositions of pupil science projects
☐ identifying community resources which can enhance science instruction
☐ insisting that science be taught for a specified amount of time
☐ assisting colleges and universities to improve teacher preparation programs in science?
☐ None of the above

36. Does your principal contribute to the science in-service education of the teaching staff by: (check all that apply)

☐ Designing programs to pump new life into old science curricula
☐ Providing in-service training programs when new science curricula are adopted or developed
☐ Arranging for colleges and universities to provide in-service instruction for credit
☐ Participating, actively, in in-service programs
☐ None of the above

District Support

37. Does your district support hands-on science education?

☐ Yes, philosophically only
☐ Yes, financially
☐ No

Please return in the enclosed self-addressed envelope no later than May 12, 1993.

Thank you for your assistance!
Appendix E

Teacher Survey and Cover Letter
(Non-Operation Physics)
Dear Teacher:

I am a doctoral student at Western Michigan University in the Department of Educational Leadership. I am also employed at the Kalamazoo Area Mathematics and Science Center. I would like your assistance in completing my research.

I am conducting a research project to determine teacher’s perception of the impact of science in-service programs on the teaching of elementary science. As a teacher who may have participated in one or more science in-services in the last two years your responses to the items on the enclosed questionnaire will be helpful in determining the areas in which the in-service has had the greatest impact.

To parallel the movement for reform in science education, the State of Michigan has established New Directions and Goals in Science Education. As our society demands scientific literacy for all students, the need to prepare our teachers for this challenge becomes more demanding. School districts, colleges, and universities across the state are taking on the challenge to improve the teaching and learning of science in elementary and middle schools.

The purpose of this study is to investigate the teacher’s perception of the impact of science in-service on the teaching of elementary science. The survey is being administered to teachers and principals in several school districts.

Your cooperation and participation in this study is appreciated. I can assure you that all questionnaire responses will be held in the strictest confidence. The code number you may notice on the questionnaire will be used only to determine those who have not responded after a period of time so that follow-up mailings to encourage response need not be sent to the entire group.

Your responses are very important. Please take the time to complete the questionnaire and return it by May 12, 1993. I thank you in advance for your valuable assistance and prompt reply.

Sincerely,

Brenda P. Earhart
Kellogg Project Coordinator
(WMU Doctoral Candidate)
Teacher Survey (Non-Operation Physics)

Part I
Please read CAREFULLY and respond to ALL questions regarding your participation in science in-service programs. If a question has more than one possible answer, please check all choices that apply. Note that several questions require you to RANK ORDER your response. When completed, return to me as soon as possible in the enclosed self-addressed envelope.

Professional Background
1. What was your undergraduate degree major? _________________________
2. Highest degree earned?
   □ Bachelor's
   □ Master's
   □ Doctorate
   □ Other
3. Total experience as an elementary school teacher?
   □ 0 to 5 years
   □ 6 to 10 years
   □ 11 to 15 years
   □ 16 to 20 years
   □ 21 to 25 years
   □ 26 or more
4. What grade level are you presently teaching? ________
5. Approximate number of students per class?
   □ 20
   □ 25
   □ 30
   □ 35
   □ Greater
6. Description of participation in science in-service
   □ Voluntary
   □ Mandatory
7. Major teaching responsibility
   □ Self-contained
   □ Science consultant
   □ Science teacher
   □ Other (explain)__________________________
8. Approximately how many hours of Operation Physics training have you had? ________
Effectiveness of science in-service

9. Have you participated in any science in-service in the last three years?
   □ Yes
   □ No

If yes, how would you describe the in-service
   □ Hands-on
   □ Lecture/discussion
   □ Demonstration
   □ Other, specify ________________________________

If your response to # 9 is no, please go to Part II.

10. Did the in-service increase your interest in the teaching of science?
    □ Yes
    □ No

11. The in-service(s) addressed my concerns in physical science as an elementary science teacher.
    □ Yes
    □ No

    If not, briefly explain why. ___________________________________________

12. I have shared with my colleagues teaching strategies learned from the science in-service(s).
    □ Yes
    □ No

    If yes, how? (check all that apply)
    □ informal sharing
    □ staff meeting
    □ grade level meeting
    □ other, specify ________________________________

13. What is your perception of the science in-service on your attitude about science and the teaching of science. Check one.
    □ attitude is more positive
    □ attitude is more negative
    □ attitude is neutral

14. Upon completion of the in-service(s) I found the approach to teaching and learning elementary science, as presented in the in-service, to be effective.
    □ Yes
    □ No

15. Have you found the materials presented in the in-service useful in the classroom?
    □ Yes
    □ No
16. The in-services were effective.
☐ Yes
☐ No

If yes, check all that apply.
☐ it provided concrete, teacher specific, training
☐ continuous modeling by the in-service presenters
☐ it allowed time for supervised practice
☐ it was not a “one-shot” effort
☐ it provided materials that could be locally developed
☐ it provided time for group and individual interaction while learning
☐ teaching and learning styles applicable to own classroom
☐ thorough, clear presentation of theory behind the approach modeled
☐ other, specify __________________________________________

17. The strategies/materials provided in the in-service activities were: (please check all that apply)
☐ directly relevant to your curriculum/course.
☐ adaptable to your curriculum/course.
☐ appropriate for your curriculum/course.

18. Were hands-on science activities included in your in-service experience?
☐ Yes
☐ No

If yes, you have: (please circle all that apply)
☐ increased student opportunities for hands-on science.
☐ increased your understanding of science concepts.
☐ increased your teaching of science concepts.
☐ changed your attitude toward science.

19. Check only the items that are true because of your science in-service experience.
☐ Became more knowledgeable about science concepts.
☐ Became more knowledgeable about the skills of science.
☐ Became more aware of the impact of science in society.
☐ Learned strategies necessary to gain adequate support for teaching science in your school.
☐ Enhanced your attitude toward science and science teaching.

20. What is your perception of your conceptual understanding of Physical Science? (√ one)
☐ Confident
☐ Moderately Confident
☐ Not Confident
☐ Not sure how I feel

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
**Instructional Strategy**

21. Please rank how often the following instructional strategies were used in your science teaching before attending the science in-service(s). Rank items (1: most frequently used strategy; 7: least frequently used strategy).

- Demonstration
- Projects (making things)
- "Hands-on" student investigations/experiments
- Lecture/Discussion
- Small group learning
- Learning centers
- Film/video

22. Please rank how often you use the instructional strategies since attending the science in-service. Please rank (1 = most frequently used; 7 = least frequently used).

- Demonstration
- Projects (making things)
- "Hands-on" student investigations/experiments
- Lecture/Discussion
- Small group learning
- Learning centers
- Film/video

23. As a result of the science in-service (s), my science classes have become more hands-on and process oriented.

☐ Yes
☐ No

24. What percentage of your science class time do you spend on hands-on science activities?

☐ 20% or less
☐ 21 - 40%
☐ 41 - 60%
☐ 61 - 80%
☐ 81 - 100%

25. As a result of the science in-service(s), the amount of time I spend teaching science in the classroom has increased.

☐ Yes
☐ No

If no, please check all that apply.

☐ Insufficient background in science
☐ Lack of materials and equipment
☐ Inadequate room facilities
☐ Lack of time
☐ Other, specify ________________________________

26. Specify the amount of time you spend teaching science.

☐ Teach science every day
☐ Teach science every other day
☐ Teach science one a week
☐ Teach science only, all day
☐ Other
27. Approximately how many minutes do you spend teaching science per science lesson?
   □  15 to 20 minutes
   □  20 to 30 minutes
   □  30 to 40 minutes
   □  more than 40 minutes
   □  less than 15 minutes

28. Have you had difficulty obtaining the materials needed to teach science?
   □ Yes
   □ No

If yes, check all that apply.
   □ science is not a priority in my school
   □ funds are not available
   □ finding materials too time consuming
   □ other, specify_____________________________

Professional Growth

29. Check the changes you have experienced as a result of the in-service(s).
   □ I attend other science in-services promoted by my interest.
   □ I attend professional meetings such as the MSTA
   □ I read more science magazines such as Science and Children
   □ I have become involved in improving my school's science curriculum.
   □ I plan and teach science differently

Administrative Support

30. Did you receive administrative support/encouragement for your participation in the in-service activities?
   □ Yes
   □ No

31. Are local school monies or petty cash provided for the science related programs in your school?
   □ Yes
   □ No

If yes, check all that apply.
   □ Science field trips
   □ In-school programs (science fair, science show, etc.)
   □ Release time for teachers to attend state science meetings
   □ Science supplies (consumable)
   □ Science or staff development.
   □ Other. Specify__________________________

32. Has your principal attended an science with you or other members of the staff?
   □ Yes
   □ No
33. Has your school had a science fair in the last two years?

☐ Yes
☐ No

If no, check all that apply.
☐ too time consuming
☐ lack of interest by staff
☐ lack of administrative support
☐ lack of funds
☐ other, specify___________________________________________

34. Based upon your observations, rank the importance your principal would assign to the following subjects. Please rank. (1 = Most important subject to teach; 5 = Least important subject to teach)

_____ Math
_____ Physical Education
_____ Reading/Language Art
_____ Science
_____ Social Studies
_____ Other_____________

35. Does your principal demonstrate leadership in science by: (check all that apply)
☐ discussing science with their teachers
☐ visiting classroom when science lessons are taught
☐ sharing science success stories as models for teachers to emulate
☐ devoting PTO meetings to science
☐ mounting a publicity campaign for science
☐ organizing public expositions of pupil science projects
☐ identifying community resources which can enhance science instruction
☐ insisting that science be taught for a specified amount of time
☐ assisting colleges and universities to improve teacher preparation programs in science
☐ none of the above

36. Does your principal contribute to the science in-service education of the teaching staff by: (check all that apply)
☐ designing programs to pump new life into old science curricula
☐ providing in-depth in-service training programs when new science curricula are adopted or developed
☐ arranging for colleges and universities to provide in-service instruction for credit
☐ participating actively in in-service programs

District Support

37. Does your district support hands-on science education?

☐ Yes, philosophically only
☐ Yes, financially
☐ No

Please return in the enclosed self-addressed envelope no later than May 12, 1993.

Thank you for your assistance
Part II

If your response to #9, Part I was No, please respond to the following items.

1. If you have not participated in a science in-service in the last three years, please check all that apply.
   □ lack of interest in science
   □ lack of administrative support
   □ lack of funds
   □ lack of time
   □ other, specify ______________________________________________________

2. My colleagues have shared teaching strategies learned from science in-services they have attended.
   □ Yes
   □ No
   If yes, how?
   □ informal sharing
   □ staff meeting
   □ grade level meeting
   □ other, specify___________________________________

3. Rank the importance you would assign to the following subjects. Please rank (1 = Most important subject to teach; 5 = Least important subject to teach).
   _____ Math
   _____ Physical Education
   _____ Reading/Language Art
   _____ Science
   _____ Social Studies
   _____ Other, specify___________________________________

4. Approximately how many hours of science in-service have you attended in the last two years?

Instructional Strategy

5. Please rank how often the following instructional strategies are used by you in teaching science. Rank items ( 1: most frequently used strategy; 7: least frequently used strategy).
   _____ Demonstration
   _____ Projects(making things)
   _____ "Hands-on" student investigations/experiments
   _____ Lecture/Discussion
   _____ Small group learning
   _____ Learning centers
   _____ Film/video

6. What percentage of science class time do you spend on hands-on science activities?
   □ 20% or less
   □ 21 - 40 %
   □ 41 - 60%
   □ 61 - 80%
   □ 81 - 100%
7. Specify the amount of time spent teaching science.

☐ Teach science every day
☐ Teach science every other day
☐ Teach science one a week
☐ Teach science only, all day
☐ Other ___________________

8. Approximately how many minutes do you spend teaching science per science lesson?

☐ 15 to 20 minutes
☐ 20 to 30 minutes
☐ 30 to 40 minutes
☐ more than 40 minutes
☐ less than 15 minutes

9. Have you had difficulty obtaining the materials needed to teach science?

☐ Yes
☐ No

If yes, briefly check all that apply.

☐ science is not a priority in my school
☐ funds are not available
☐ finding materials too time consuming
☐ other, specify _______________________

Administrative Support

10. Does your principal encourage you to participate in science in-services?

☐ Yes
☐ No

11. Are local school monies or petty cash provided for science related programs in your school? (check all that apply)

☐ Yes
☐ No

If yes, check all that apply.

☐ Science field trips
☐ In-school programs (science fair, science show, etc.)
☐ Release time for teachers to attend state science meetings
☐ Science in-service for teachers
☐ Science supplies (consumable)
☐ Science or staff development.
☐ Other. Specify _______________________

12. Has your principal attended a science in-service with you or other members of the staff?

☐ Yes
☐ No
13. Has your school had a science fair in the last two years?

☐ Yes
☐ No

If no, check all that apply.

☐ too time consuming
☐ lack of interest by staff
☐ lack of administrative support
☐ lack of funds
☐ other, specify____________________________________

14. Based upon your observations, rank the importance your principal would assign to the following subjects. Please rank. (1 = Most important subject to teach; 5 = Least important subject to teach)

☐ Math
☐ Physical Education
☐ Reading/Language Art
☐ Science
☐ Social Studies
☐ Other____________________________________

15. Does your principal demonstrate leadership in science by: (check all that apply)

☐ discussing science with their teachers
☐ visiting classroom when science lessons are taught
☐ sharing science success stories as models for teachers to emulate
☐ devoting PTO meetings to science
☐ mounting a publicity campaign for science
☐ organizing public expositions of pupil science projects
☐ identifying community resources which can enhance science instruction
☐ insisting that science be taught for a specified amounts of time
☐ assisting colleges and universities to improve teacher preparation programs in science
☐ None of the above

16. Does your principal contribute to the science in-service education of the teaching staff by: (check all that apply)

☐ designing programs to pump new life into old science curricula
☐ providing in-depth training programs when new science curricula are adopted or developed
☐ arranging for colleges and universities to provide instruction for credit
☐ participating, actively, in programs
☐ None of the above

17. Does your district support hands-on science education?

☐ Yes, philosophically only
☐ Yes, financially
☐ No

Please return in the enclosed self-addressed envelope no later than May 12, 1993.

Thank you for your assistance!
Appendix F
Principal Survey and Cover Letter
Dear Principal:

I am a doctoral student at Western Michigan University in the Department of Educational Leadership. I am also employed at the Kalamazoo Area Mathematics and Science Center. I would like your assistance in completing my research.

I am conducting a research project to determine principals' perception of the impact of OPERATION PHYSICS in-service programs on the teaching of elementary science and your perception of the principal's role in elementary school science. As a principal of three or more teachers who have participated in OPERATION PHYSICS in-services in the last three years your responses to the items on the enclosed questionnaire will be helpful in determining the areas in which the in-service program has had the greatest impact.

To parallel the movement for reform in science education, the State of Michigan has established New Directions and Goals in Science Education. As our society demands scientific literacy for all students, the need to prepare our teachers for this challenge becomes more demanding. School districts, colleges, and universities across the state are taking on the challenge. OPERATION PHYSICS, one of many in the state of Michigan, to improve the teaching and learning of science in elementary and middle schools.

The purpose of this study is to investigate the teacher's and principal's perception of the impact of OPERATION PHYSICS in-service program on the teaching of elementary science AND to determine your perception of the principal's role in elementary science. Surveys are being administered to teachers and principals in several school districts.

Your cooperation and participation in this study is appreciated. I can assure you that all questionnaire responses will be held in the strictest confidence. The code number you may notice on the questionnaire will be used only to determine those who have not responded after a period of time so that follow-up mailings to encourage response need not be sent to the entire group.

Your responses are very important. Please take the time to complete the questionnaire and return it by May 12, 1993. I thank you in advance for your valuable assistance and prompt reply.

Sincerely,

Brenda P. Earhart
Kellogg Project Coordinator
(WMU Doctoral Candidate)
Principal Survey

Please read CAREFULLY and respond to ALL questions. If a question has more than one possible answer, please ✓ all choices that apply. Note that several questions require you to rank order your responses.

Your school facilities and events for science

1. Does your school have any of the following facilities for teaching science?
   - Access to Nature trail or Nature Center
   - Separate science lab or resource room
   - Greenhouse for science based activities
   - School garden
   - Other, specify __________________________________________

Your science inservice/staff development program

2. Have you provided a science inservice or staff development program for your teachers in your building this school year?
   - Yes
   - No

3. Who planned the most recent science inservice/staff development program?(check all that apply)
   - You, the principal
   - Your teachers
   - Science or other supervisory personnel
   - A committee of teachers and principal
   - State/regional science personnel
   - District office personnel
   - Other, specify __________________________________________

4. Have you attended a science staff development program in the past two years?
   - No
   - Yes

5. Have you attended an Operation Physics workshop with any of your staff?
   - Yes
   - No
   If yes, please indicated the number of sessions attend ____________.

Your local school budget (check all that apply)

6. Does your district or building provide funds for implementing the following science related programs in your school?
   - Science field trips
   - In-school programs (science fair, science show)
   - Release time for teachers to attend state science meetings
   - Science inservice for teachers

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
7. What staff members had input into the purchasing of science supplies with those monies?

- The principal
- Teachers with special requests
- Committee of teachers and principals
- Teachers who have participated in Operation Physics
- Other (specify) __________________________

Your teaching staff and the science curriculum

8. What is the number of classroom teachers in your school? ______

9. Do you have any teachers who teach only science in grades K - 6?

- Yes
- No

10. What is the number of classroom teachers that have participated in at least one Operation Physics Inservice? ______

11. Based upon your observations, rank the importance your teachers would assign to the following subjects. (1 = most important subject to teach; 5 = least important to teach)

Math
_____ Reading/Language Arts
_____ Science
_____ Social Studies

12. Based upon your observations, rank the importance your teachers participating in Operation Physics workshops would assign to the following subjects. (1 = most important subject to teach; 5 = least important to teach)

Math
_____ Reading/Language Arts
_____ Science
_____ Social Studies

13. What is your perception of your teachers trained in Operation Physics (OP) conceptual understanding of Physical Science?

- Confident with physical science concepts
- Moderately comfortable with physical science concepts
- Not confident with physical science concepts
- Not sure about OP teachers conceptual understanding of physical science

14. What is your perception of the attitude your teachers trained in Operation Physics exhibit towards the teaching of science?

- More enthused about teaching science
- Less enthused about teaching science
- Attending more science workshops
- Science lessons are more activity based
- Request more materials for teaching science
- Their students are more excited about the learning of science
15. Please rank the following factors described below as possible reasons for teachers not teaching science. (1 = Most likely to prevent science from being taught; 9 = Least likely to prevent science from being taught)

   - Lack of supplies and equipment
   - Inability to improvise materials and equipment
   - Insufficient understanding of science concepts
   - Emphasis on math and reading
   - Insufficient time to teach science
   - Inappropriate textbook
   - Inadequate room facilities
   - Lack of understanding of methods of teaching science
   - Insufficient funds
   - Other, please specify

16. In your opinion, how often should science activities be presented in the classroom?

   - Teach science every day
   - Teach science every other day
   - Teach science once a week
   - Teach science only, all day

17. In your opinion, how many minutes should be spent per science lesson?

   - 15 to 20 minutes
   - 20 to 30 minutes
   - 30 to 40 minutes
   - More than 40 minutes
   - Less than 15 minutes

18. Do any of the following staff members assist with developing science curriculum? (check all that apply)

   - Elementary Science Supervisor
   - K-12 Science Supervisor
   - Science Demonstration teacher
   - Science Consultant
   - Teachers who have been trained in Operation Physics
   - Other, specify

19. Rank the following instructional strategies that you feel are used in teaching science at your school. Please rank (1 = most frequently used strategy; 7 = least frequently used strategy)

   - Demonstration
   - Projects (making things)
   - "Hands-on" student investigations/experiments
   - Lecture/Discussion
   - Small group learning
   - Learning centers
   - Film/video
20. What percentage of your staff have you observed teaching a science lesson during this school year?

☐ None
☐ 1% to 25%
☐ 26% to 50%
☐ 51% to 75%
☐ 76% to 100%

21. Please rank the items based on the importance you assign to the following subjects. Please rank (1 = most important subject to teach; 5 = least important subject to teach).

Math  ___  Physical Education  ____  Science  ___  Reading/Language Art  ____  Social Studies

22. Do you demonstrate leadership in science by: (check all that apply)

☐ discussing science with your teachers
☐ visiting classroom when science lessons are taught
☐ sharing science success stories as models for teachers to emulate
☐ devoting PTO meetings to science
☐ mounting a publicity campaign for science
☐ organizing public expositions of pupil science projects
☐ identifying community resources which can enhance science instruction
☐ insisting that science be taught for a specified amount of time
☐ assisting colleges and universities to improve teacher preparation programs in science
☐ none of the above

23. Do you contribute to the in-service education of the teaching staff by: (check all that apply)

☐ designing programs to pump new life into old science curricula
☐ providing in-depth inservice training programs when new science curricula are adopted or developed
☐ arranging for colleges and universities to provide inservice instruction for credit
☐ participating, actively, in inservice programs

24. Does your district support hands-on science education?

☐ Yes, philosophically only
☐ Yes, financially
☐ No

If no, why?

☐ Lack of funds
☐ guidelines that disallow teaching of science in favor of math/reading
☐ other, specify ___________________
Demographics

24. What is your building population?
   - 50 - 150 students
   - 151 - 300 students
   - 301 - 500 students
   - 500 or more students

25. How would you describe your school district?
   - Rural
   - Urban
   - Suburban
   - Other- please describe______________________________

Please return in the enclosed self-addressed envelope by May 12, 1993.

Thank you for your assistance!
Appendix G

Letters Requesting Participation in the Pilot Study
Dear Teacher:

I am a doctoral student at Western Michigan University in the Department of Educational Leadership. I am also employed at the Kalamazoo Area Mathematics and Science Center. I would like your assistance in completing my research.

I am in the process of pilot testing the research instrument to be used in conjunction with my doctoral dissertation at Western Michigan University. It is my hope that you are willing to help in this process by completing the enclosed questionnaire.

The purpose of this study is to investigate the teacher’s and principal’s perception of the impact of science in-service programs on the teaching of elementary science AND to determine your perception of the principal’s role in elementary science. Surveys are being administered to teachers and principals in several school districts.

To parallel the movement for reform in science education, the State of Michigan has established New Directions and Goals in Science Education. As our society demands scientific literacy for all students, the need to prepare our teachers for this challenge becomes more demanding. School districts, colleges, and universities across the state are taking on the challenge. Science inservice is one of many efforts in the state of Michigan to improve the teaching and learning of physics concepts in the upper elementary and middle schools.

Your cooperation and participation in this study is appreciated. I can assure you that all questionnaire responses will be in the strictest confidence. The code number you may notice on the questionnaire will be used only to determine those who have not responded after a period of time so that follow-up mailings to encourage response need not be sent to the entire group.

Please complete and return by April 23, 1993. Thank you for your valuable assistance and prompt reply.

Sincerely,

Brenda P. Earhart
Kellogg Project Coordinator
(WMU Doctoral Candidate)
Dear Principal:

I am a doctoral student at Western Michigan University in the Department of Educational Leadership. I am also employed at the Kalamazoo Area Mathematics and Science Center. I would like your assistance in completing my research.

I am in the process of pilot testing the research instrument to be used in conjunction with my doctoral dissertation at Western Michigan University. It is my hope that you are willing to help in this process by completing the enclosed questionnaire.

The purpose of this study is to investigate the teacher’s and principal’s perception of the impact of OPERATION PHYSICS in-service program on the teaching of elementary science AND to determine your perception of the principal’s role in elementary science. Surveys are being administered to teachers and principals in several school districts.

To parallel the movement for reform in science education, the State of Michigan has established New Directions and Goals in Science Education. As our society demands scientific literacy for all students, the need to prepare our teachers for this challenge becomes more demanding. School districts, colleges, and universities across the state are taking on the challenge. OPERATION PHYSICS, one of many in the state of Michigan, is a major effort to improve the teaching and learning of physics concepts in the upper elementary and middle schools.

Your cooperation and participation in this study is appreciated. I can assure you that all questionnaire responses will be in the strictest confidence. The code number you may notice on the questionnaire will be used only to determine those who have not responded after a period of time so that follow-up mailings to encourage response need not be sent to the entire group.

Please complete and return by April 23, 1993. Thank you for your valuable assistance and prompt reply.

Sincerely,

Brenda P. Earhart
Kellogg Project Coordinator
(WMU Doctoral Candidate)
Appendix H

Follow-up Letters to Nonrespondents
May 15, 1993

Dear Teacher:

I know this is an extremely busy time of the year for you but I would really appreciate it if you would take 5 minutes to complete the survey you receive from me the first part of the month. It only takes about 5 minutes. Please complete and place in the mail today.

Thank you for completing the survey.

Sincerely,

Brenda P. Earhart
Kellogg Project Coordinator
WMU Doctoral Candidate
May 15, 1993

Dear Principal:

I know this is an extremely busy time of the year for you but I would really appreciate it if you would take 5 minutes to complete the survey you receive from me the first part of the month. It only takes about 5 minutes. Please complete and place in the mail today.

Thank you for completing the survey.

Sincerely,

Brenda P. Earhart
Kellogg Project Coordinator
WMU Doctoral Candidate
Appendix I

Approval Letter From Human Subjects
Institutional Review Board
Date: April 16, 1993
To: Brenda Prater Earhart
From: M. Michele Burnette, Chair
Re: HSIRB Project Number 93-03-28

This letter will serve as confirmation that your research project entitled "The teacher's and principal's perceptions of the impact of OPERATION PHYSICS on the teaching of elementary science in Michigan schools" has been approved under the exempt category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the approval application.

You must seek reapproval for any changes in this design. You must also seek reapproval if the project extends beyond the termination date.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: April 16, 1994

xc: Smidchens, EL
Appendix J
Raw Data
## Factors Affecting the Teaching of Science as Perceived by the Principal (Question 15)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Rank by number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of supplies and equipment</td>
<td>1 0 1 3 2 0 0 1</td>
</tr>
<tr>
<td>Inability to improvise materials</td>
<td>0 2 3 1 5 0 0 0</td>
</tr>
<tr>
<td>Insufficient understanding of science concepts</td>
<td>2 2 0 0 1 1 1 1</td>
</tr>
<tr>
<td>Emphasis on mathematics and reading</td>
<td>0 1 1 1 2 2 0 0</td>
</tr>
<tr>
<td>Insufficient time</td>
<td>1 0 1 1 0 1 0 2</td>
</tr>
<tr>
<td>Inappropriate textbooks</td>
<td>0 0 0 1 1 2 1</td>
</tr>
<tr>
<td>Inadequate room facilities</td>
<td>3 0 2 1 0 0 0 1</td>
</tr>
<tr>
<td>Lack of understanding of methods of teaching science</td>
<td>1 3 1 0 0 1 1 1</td>
</tr>
<tr>
<td>Insufficient funds</td>
<td>0 0 1 0 0 0 3 1</td>
</tr>
</tbody>
</table>
### MOP Participants' Ranking of Teaching Strategies Used Before MOP In-Service Training (Question 21)

<table>
<thead>
<tr>
<th>Rank by number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstration</td>
<td>7</td>
<td>7</td>
<td>8</td>
<td>8</td>
<td>4</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Lecture/demonstration</td>
<td>2</td>
<td>7</td>
<td>8</td>
<td>6</td>
<td>8</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Hands-on</td>
<td>10</td>
<td>5</td>
<td>10</td>
<td>4</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Projects</td>
<td>17</td>
<td>3</td>
<td>0</td>
<td>7</td>
<td>3</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Small group learning</td>
<td>2</td>
<td>6</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Film/video</td>
<td>0</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>Learning center</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>9</td>
<td>7</td>
<td>5</td>
<td>10</td>
</tr>
</tbody>
</table>

### MOP Participants' Ranking of Teaching Strategies Used After MOP In-Service Training (Question 22)

<table>
<thead>
<tr>
<th>Rank by number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstration</td>
<td>7</td>
<td>7</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Lecture/demonstration</td>
<td>6</td>
<td>7</td>
<td>2</td>
<td>9</td>
<td>7</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Hands-on</td>
<td>14</td>
<td>8</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Projects</td>
<td>8</td>
<td>5</td>
<td>1</td>
<td>7</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Small group learning</td>
<td>2</td>
<td>7</td>
<td>6</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Film/video</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>4</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>Learning center</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>12</td>
<td>9</td>
</tr>
</tbody>
</table>
### Non-MOP Participants' Ranking of Teaching Strategies Used Before Participation in Science In-Service Training (Question 21)

<table>
<thead>
<tr>
<th>Rank by number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demonstration</strong></td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Lecture/demonstration</strong></td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Hands-on</strong></td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Projects</strong></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Small group learning</strong></td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Film/video</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>Learning center</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

### Non-MOP Participants' Ranking of Teaching Strategies Used After Participation in Science In-Service Training (Question 22)

<table>
<thead>
<tr>
<th>Rank by number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demonstration</strong></td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Lecture/demonstration</strong></td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Hands-on</strong></td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Projects</strong></td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Small group learning</strong></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Film/video</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td><strong>Learning center</strong></td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
BIBLIOGRAPHY


Harns, N. C. (1977). *Project synthesis: An interpretive consolidation of research identifying needs in natural science education.* A proposal submitted to the National Science Foundation, University of Colorado, Boulder. (NSF Grant No. SED 77-19001)


Hausman, H. J. (1978). Influence of funding by the United States government on the teaching of science in the elementary and


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.


