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AN EXPLORATORY INVESTIGATION OF VERBAL AND NON-VERBAL BEHAVIORS OF BSCS TEACHERS AND NON-BSCS TEACHERS.

The Ohio State University, Ph. D., 1968
Education, general

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1968
AN EXPLORATORY INVESTIGATION OF VERBAL AND
NON-VERBAL BEHAVIORS OF BSCS TEACHERS
AND NON-BSCS TEACHERS

DISSERTATION
Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By
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* * * * *

The Ohio State University
1968

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PREFACE

THE UNIQUE NATURE OF THE STUDY

The study reported in this dissertation and a study by Mr. Thomas P. Evans were parallel in part and independent in part. In general, the two researchers worked together on arrangements with school systems and teachers, video tape recording in the classrooms, instrument development, and observer agreement. Analyses and interpretations of the data were made independently. The reports were written separately and are not the same. Details pertaining to those areas of investigation that were done jointly and those that were done independently are reported in Chapter III.
ACKNOWLEDGMENTS

The author expresses his sincere gratitude to Dr. John S. Richardson, major adviser, for his challenges, guidance, and encouragement throughout this study. His numerous contributions to quality and enthusiasm were a major asset.

The cooperation and assistance by the personnel of the Greater Cincinnati area schools involved in this study were superb. The high level of professional cooperation greatly facilitated successful completion of the study.

Professor L. O. Andrews, Professor Charles Galloway, and Professor Clarence E. Taft made numerous contributions to this study, especially in the design and proposal stages. My sincere appreciation is extended to each of them.

The tireless effort and vast store of ideas contributed by Mr. Thomas P. Evans, co-researcher, are greatly appreciated. His contributions were of great significance in the development of this study.

Alice Balzer contributed immeasurably in the forms of typing, checking of tabular data, kindness, and patience. Cary Balzer and Tanya Balzer aided through frequent adjustments of their schedules and considerable patience.
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Studies in Science Education.  Professor John S. Richardson

Studies in Biology.  Professor Clarence E. Taft

Studies in Teacher Education.  Professor Leonard O. Andrews
## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREFACE</td>
<td>ii</td>
</tr>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>iii</td>
</tr>
<tr>
<td>VITA</td>
<td>iv</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>vii</td>
</tr>
<tr>
<td><strong>CHAPTER</strong></td>
<td></td>
</tr>
<tr>
<td>I INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Problem</td>
<td>1</td>
</tr>
<tr>
<td>Hypotheses</td>
<td>4</td>
</tr>
<tr>
<td>Definition of Terms</td>
<td>5</td>
</tr>
<tr>
<td>Assumptions</td>
<td>7</td>
</tr>
<tr>
<td>Limitations and Delimitations</td>
<td>7</td>
</tr>
<tr>
<td>Need for the Study</td>
<td>9</td>
</tr>
<tr>
<td>The Method</td>
<td>12</td>
</tr>
<tr>
<td>II REVIEW OF RELATED LITERATURE</td>
<td>16</td>
</tr>
<tr>
<td>Representative Teacher Behavior and Classroom Interaction Studies</td>
<td>18</td>
</tr>
<tr>
<td>Science Teacher Behavior and Classroom Interaction Studies</td>
<td>62</td>
</tr>
<tr>
<td>III THE METHOD</td>
<td>77</td>
</tr>
<tr>
<td>Selection of School Systems and Teachers</td>
<td>78</td>
</tr>
<tr>
<td>Cooperating in the Study</td>
<td></td>
</tr>
<tr>
<td>The Use of Video Tape Recording Equipment</td>
<td>80</td>
</tr>
<tr>
<td>in the Schools</td>
<td></td>
</tr>
<tr>
<td>Instrument Development</td>
<td>86</td>
</tr>
<tr>
<td>Development of Processes for Encoding</td>
<td>89</td>
</tr>
<tr>
<td>Behaviors</td>
<td></td>
</tr>
<tr>
<td>Observer Agreement</td>
<td>91</td>
</tr>
<tr>
<td>Data Collection, Encoding, and Analysis</td>
<td>95</td>
</tr>
<tr>
<td>CHAPTER</td>
<td>Page</td>
</tr>
<tr>
<td>------------</td>
<td>------</td>
</tr>
<tr>
<td>IV THE RESULTS.</td>
<td>101</td>
</tr>
<tr>
<td>Statement of the Problem and Method</td>
<td>101</td>
</tr>
<tr>
<td>The First and Second Hypotheses</td>
<td>102</td>
</tr>
<tr>
<td>The Third and Fourth Hypotheses</td>
<td>115</td>
</tr>
<tr>
<td>The Fifth and Sixth Hypotheses</td>
<td>136</td>
</tr>
<tr>
<td>V SUMMARY, CONCLUSIONS, AND IMPLICATIONS</td>
<td>147</td>
</tr>
<tr>
<td>Summary</td>
<td>147</td>
</tr>
<tr>
<td>Implications</td>
<td>164</td>
</tr>
<tr>
<td>Supplementary Implications</td>
<td>167</td>
</tr>
<tr>
<td>Recommendations for Further Study</td>
<td>171</td>
</tr>
</tbody>
</table>

APPENDIXES

<table>
<thead>
<tr>
<th>APPENDIX</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A GENERAL DESCRIPTION OF REQUESTED RESEARCH RESOURCES AND OPPORTUNITIES</td>
<td>175</td>
</tr>
<tr>
<td>B</td>
<td>POST-DATA COLLECTION LETTER OF RECOGNITION AND APPRECIATION</td>
<td>178</td>
</tr>
<tr>
<td>C</td>
<td>DATA RECORD</td>
<td>181</td>
</tr>
<tr>
<td>D</td>
<td>MASTER DATA RECORD.</td>
<td>183</td>
</tr>
<tr>
<td>E</td>
<td>BIOLOGY TEACHER BEHAVIOR INVENTORY, CATEGORIES OF TEACHER CLASSROOM BEHAVIOR</td>
<td>187</td>
</tr>
<tr>
<td>F</td>
<td>BIOLOGY TEACHER BEHAVIOR INVENTORY, DEFINITIONS OF THE CATEGORIES AND SUB-CATEGORIES OF TEACHER CLASSROOM BEHAVIOR</td>
<td>192</td>
</tr>
<tr>
<td>G</td>
<td>BIOLOGY TEACHER BEHAVIOR INVENTORY, GLOSSARY OF TEACHER CLASSROOM BEHAVIORS</td>
<td>200</td>
</tr>
<tr>
<td>BIBLIOGRAPHY</td>
<td>223</td>
<td></td>
</tr>
<tr>
<td>Table</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
<td>------</td>
</tr>
<tr>
<td>1</td>
<td>OBSERVER AGREEMENT BASED ON THE SCOTT COEFFICIENT OF INTER-CODER AGREEMENT.</td>
<td>111</td>
</tr>
<tr>
<td>2</td>
<td>PERCENTAGE OF BEHAVIORS BY TEACHERS IN EACH CATEGORY.</td>
<td>116</td>
</tr>
<tr>
<td>3</td>
<td>PERCENTAGE OF BEHAVIORS BY TEACHERS IN EACH SUBCATEGORY.</td>
<td>118</td>
</tr>
<tr>
<td>4</td>
<td>PERCENTAGE OF CONTENT DEVELOPMENT BY TEACHERS IN THE SUBDIVISIONS OF CONTENT DEVELOPMENT.</td>
<td>119</td>
</tr>
<tr>
<td>5</td>
<td>PERCENTAGE OF BEHAVIORS BY TEACHERS IN THE VARIOUS FORMS OF EXPRESSION.</td>
<td>120</td>
</tr>
<tr>
<td>6</td>
<td>PERCENTAGE OF CONTENT DEVELOPMENT BY TEACHERS COMPRISED OF THE VARIOUS COMMUNICATION ACTS.</td>
<td>121</td>
</tr>
<tr>
<td>7</td>
<td>RANKS OF THE CATEGORIES OF BEHAVIOR ACCORDING TO PERCENTAGE OF TOTAL BEHAVIORS OF EACH TEACHER.</td>
<td>122</td>
</tr>
<tr>
<td>8</td>
<td>RANKS OF THE SUBDIVISIONS OF CONTENT DEVELOPMENT ACCORDING TO PERCENTAGE OF CONTENT DEVELOPMENT WITHIN EACH SUBDIVISION FOR EACH TEACHER.</td>
<td>124</td>
</tr>
<tr>
<td>9</td>
<td>RANKS OF THE MAJOR SUBCATEGORIES AND THE SUBDIVISIONS OF CONTENT DEVELOPMENT ACCORDING TO PERCENTAGE OF TOTAL BEHAVIORS BY EACH TEACHER.</td>
<td>125</td>
</tr>
<tr>
<td>10</td>
<td>H VALUES FOR THE SIX CATEGORIES</td>
<td>131</td>
</tr>
<tr>
<td>Table</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>-------</td>
<td>------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>11</td>
<td>H VALUES FOR THE SUBCATEGORIES AND SUBDIVISIONS OF THE BIOLOGY TEACHER BEHAVIOR INVENTORY</td>
<td>132</td>
</tr>
<tr>
<td>12</td>
<td>PERCENTAGE OF BEHAVIORS OF BSCS TEACHERS AND NON-BSCS TEACHERS IN EACH MAJOR CATEGORY</td>
<td>138</td>
</tr>
<tr>
<td>13</td>
<td>PERCENTAGE OF BEHAVIORS OF BSCS TEACHERS AND NON-BSCS TEACHERS IN EACH SUBCATEGORY</td>
<td>139</td>
</tr>
<tr>
<td>14</td>
<td>PERCENTAGE OF CONTENT DEVELOPMENT BEHAVIORS IN EACH SUBDIVISION OF CONTENT DEVELOPMENT BY BSCS AND NON-BSCS TEACHERS</td>
<td>139</td>
</tr>
<tr>
<td>15</td>
<td>U VALUES FOR THE SIX CATEGORIES BASED ON NON-BSCS TEACHERS AND BSCS TEACHERS</td>
<td>142</td>
</tr>
<tr>
<td>16</td>
<td>U VALUES FOR THE SUBCATEGORIES AND SUBDIVISIONS OF THE BIOLOGY TEACHER BEHAVIOR INVENTORY</td>
<td>143</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

Problem

Considerable research and study have been done recently in the field of teacher verbal behavior. Furthermore, considerable attention is now being given to student learning behaviors such as the development of concepts and problem solving ability. Also, there is hope now that by obtaining measures of behavior change (student gain) and by identifying patterns of teacher behavior, meaningful relationships involved in the effective teaching-learning situation may be found. Medley and Mitzel have emphasized the importance of differentiation of effective and ineffective teachers by identification of patterns of behavior (1963, p. 249). It is not yet possible to do this strictly by direct observation of the teacher since teacher effectiveness must be ultimately defined in terms of changes in pupil behavior. Clearly, the relationships between the various aspects of pupil behavior change and various patterns of teacher behavior have not been firmly
established. In science education, it appears that one of the early steps to be taken is the development of a more adequate understanding about what comprises behaviors of science teachers in the classroom.

Ryans (1960) pointed out that effective and ineffective teachers cannot be described with any assurance because of the wide variation in value concepts underlying descriptions of desirable teaching objectives and differences in teacher role at various educational levels, in various subjects, and with different pupils. He pointed out also that there is a lack of any clear knowledge of "the patterns of behavior that typify individuals who are employed as teachers." He then stated:

It seems probable that, without losing sight of the importance of developing means of recognizing "good" teachers, attention of the researcher might first more properly and profitably be directed at the identification and estimation of some of the major patterns of personal and social characteristics of teachers (1960, p. 371).

It seemed appropriate to the researcher to infer on the basis of the scarcity of behavior studies in science education that the above statements were appropriate in the field of science education. It was in this context that the researcher undertook a descriptive and interpretive study of science teacher behavior. The study was
designed to identify behaviors and patterns of behavior of biology teachers. The intent was that this be accomplished by video tape recording and observation and analysis of ongoing teacher behaviors by means of a study of these records. This was considered a more direct approach than recall by an observer, measurement of changes in student behavior, or utilization of student recollection and interpretation of teacher behaviors. This approach was considered defensible in spite of the desirability of studying student behavior since the focus was upon identification of teacher behaviors and patterns of behavior. A further objective was to study these behaviors and patterns of behavior in relation to whether or not BSCS materials were being used in the classroom.

The purpose, then, was to achieve the following objectives:

1. To develop an instrument for the categorization of biology teacher behaviors.

2. To record behaviors and patterns of biology teacher behavior by means of utilization of the instrument on video tape recordings taken in the classroom.

3. To identify aspects of teacher behavior patterns that differ significantly among teachers and aspects that appear relatively similar or correlate highly among teachers.
4. To identify behaviors and/or patterns of teacher verbal and non-verbal behavior that differ significantly between BSCS teachers and non-BSCS teachers.

**Hypotheses**

1. An instrument incorporating both verbal and non-verbal behaviors of biology teachers can be developed.

2. An instrument that meets the above requirements can be constructed on a category basis to incorporate behaviors pertinent to studies of teacher behavior with widely differing objectives.

3. Some aspects of biology teacher verbal and non-verbal behavior are identifiable which correlate highly for the biology teachers involved in the study.

4. Some aspects of biology teacher verbal and non-verbal behavior vary substantially, and can be identified as significantly different.

5. Some aspects of BSCS teacher verbal and non-verbal behavior are significantly different from those of non-BSCS teachers.

6. BSCS teachers exhibit verbal and non-verbal behaviors which promote achievement of BSCS objectives to a greater degree than non-BSCS teachers.
Definition of Terms

1. Biology teacher. Any teacher identified by the superintendent or science supervisor of the school system involved as a teacher of biological science at grades 9-12 is considered a biology teacher. In this study, all biology teachers involved taught at least four biological science classes per day.

2. BSCS teacher. Any biology teacher identified by the superintendent or science supervisor of the school system involved as a Biological Sciences Curriculum Study teacher is referred to as a BSCS teacher in this study.

3. Teacher behaviors. Everything identifiable that the teacher does in the classroom that is judged by the observer to influence the teaching-learning situation in the classroom is considered a teacher behavior. Included are various verbal and non-verbal behaviors.

4. Teacher verbal behaviors. In this study, verbal behaviors are constituted of those oral teacher behaviors in which there is actual usage of the language.

5. Teacher non-verbal behaviors. Teacher behaviors which are not comprised of oral usage of the language are considered non-verbal behaviors. Included are such specific behaviors as
6. Behavior patterns. The combinations of various specific behaviors of a teacher are considered to comprise a behavior pattern.

7. Instrument. The term "instrument" as used in this study pertains to a device through which the various behaviors of a biology teacher can be classified on a category basis.

8. Category. This is a major division or section of the instrument into which certain behaviors are classified and from which all other behaviors are excluded. In other words, the categories of the instrument are mutually exclusive.

9. Observer agreement. This is the degree of inter-observer agreement as obtained by use of the Scott Index of Inter-coder Agreement. By use of this procedure, the degree of agreement between individuals using the instrument in classification of biology teacher behaviors is measured.

10. BSCS objectives. These are the principal instructional concerns of BSCS as obtained from BSCS literature and reported statements regarding concerns by persons closely associated with BSCS.
Assumptions

1. Certain verbal and non-verbal behaviors of science teachers are observable or audible and can be identified and categorized.

2. Teacher behaviors can be interpreted to a certain extent. In other words, meaning beyond purely objective description (such as inference of behavioral intent) can be attributed to teacher behaviors with reliability.

3. Teacher verbal and non-verbal behaviors are instrumental in achieving objectives.

4. Some instruction-related BSCS objectives can be identified.

Limitations and Delimitations

1. Limitations of time, finances, school resources, and personnel were such that it was not feasible to attempt to make inferences concerning the behaviors of biology teachers beyond the teachers involved in the study. This study was considered to be of an exploratory nature with a limited sample of teachers administratively identified. Such selection of the sample as contrasted with randomization sharply limited the strength of external validity.
2. In this study, attention was focused on teacher verbal and non-verbal behavior. Furthermore, emphasis was placed on description and interpretation of teacher behavior. An attempt was made also to relate differences in teacher behavior to objectives of the BSCS, but there was no attempt to evaluate teacher behavior or to evaluate the effectiveness either subjectively or in terms of pupil gain.

3. The researcher made no attempt to evaluate the appropriateness of BSCS objectives or the value of BSCS materials. An attempt was made to discern whether teachers using BSCS materials behaved differently from those not using BSCS materials.

4. Teacher-pupil interaction was recognized as basic to effective communication; nevertheless, it was considered necessary to concentrate attention in this study on the behavior of teachers. Pupil behavior was taken into account only as necessary for adequate description and interpretation of teacher behavior and as feasible within limits of instrument complexity and technological capabilities.

5. In this study, it was not possible to insure that the behaviors of the teachers were unaffected by the presence of the researcher and the recording equipment. A possible introduction of
bias into actual behaviors was therefore recognized, although the procedures described later in this study were executed carefully in an attempt to limit bias insofar as possible.

**Need for the Study**

Numerous attempts have been made to identify and categorize teacher behaviors. It has appeared to the researcher, however, that the acquisition of adequate information in a reliable manner would involve intricate processes and instrumentation that were not being developed in science education. Only after the techniques of acquisition and the information are available is it possible to relate this information to such important variables as the program of teacher education, the personality of the teacher, and the materials being used in the classroom. It is just as evident that the described steps are preliminary to a serious scientific study of the relationship of science teacher verbal and non-verbal behaviors to changes in pupil behavior, pupil gain, and, in short, teacher competency and effectiveness. It seems apparent also that such basic information about teacher behavior could be used to great advantage by the teacher in self improvement, an aspect of substantial potential for in-service programs, workshops, and the like.
Achievement of objectives has often been a matter of major concern to educators. In this study, there was no attempt to judge the value of various objectives in biology teaching, but it was assumed that the verbal and non-verbal behaviors of the teacher are pertinent in relation to the achievement of instructional objectives. In other words, it was considered that it is the behavior of the teacher in the classroom and not his mere presence that is of significance in the achievement of objectives, if indeed the teacher is of importance in the achievement of objectives. It seems evident that an understanding of behavior has potential in eventually facilitating achievement of objectives.

The preceding discussion implies that an understanding of teacher behavior may aid educators and scientists in the development of teacher education programs that more effectively prepare teachers to achieve given objectives. The degree to which teacher behavior currently corresponds to stated or implied instructional objectives of course content materials has also not been adequately investigated. It may be that some recent course content improvement projects such as BSCS and perhaps school systems as well have assumed that the behavior of teachers using their materials differs from that of other teachers, especially if the former have taken a course pertaining to the teaching of BSCS biology.
The following specific justifications were considered pertinent to the preceding general framework of the problem:

1. Much attention has recently been focused on teacher verbal behavior; non-verbal behavior has been relatively neglected. The writer assumes that non-verbal behavior is also important in the teaching-learning situation and that it is essential that both aspects be given attention.

2. It is apparent from previous teacher behavior studies that considerable difficulty is involved in orderly identification and encoding of teacher behavior. While another attempt is not likely to solve the problem entirely, it should contribute to progress in this area. It is certainly pertinent to science education that an attempt be made to study the behavior of science teachers and to provide an instrument for the identification and encoding of teacher behavior.

3. There are attempts to identify experimentally the nature of effective teaching, with conceptual frameworks ranging from characteristics of teachers as in the Ryans study (1960) to the effective use of self as proposed by Combs (1965). More information about the nature of teacher behavior in the classroom should be applicable to various conceptual frameworks concerning effectiveness.
4. It seems desirable to consider a major science course improvement project such as BSCS and its guiding philosophy in relation to teacher behaviors. These relationships should be investigated rather than assumed or ignored.

The Method

Selection of school systems and teachers cooperating in the study

Biology teachers from several school systems of Cincinnati, Ohio, and the Greater Cincinnati area, were involved in the study. Teachers who were invited to participate in the study were utilized only after their voluntary indication of willingness to participate. In all, eleven biology teachers were contacted and all indicated a willingness to participate in the study. The teachers represented a wide range of schools and teaching assignments though all were secondary school biology teachers.

At least one video tape recording was made of each teacher during the spring of 1967 and the instrument for identification and categorization of teacher behaviors was developed from these video tapes. It was planned that during the fall of 1967, each of eight biology teachers should be video tape recorded five times. Eight of the eleven biology teachers were contacted and all eight again
indicated a willingness to continue participation in the study. Four of the teachers were identified as BSCS teachers by their superintendent or science supervisor and four were identified as non-BSCS teachers.

The use of video tape recording equipment in the schools

The equipment utilized in this research was portable video tape recording equipment. In this manner, a record of teacher behaviors was preserved for repeated study. Instrument development and accuracy in encoding data were considerably facilitated by the opportunity to use this record of teacher behaviors repeatedly.

Instrument development

Thirteen video tapes involving eleven biology teachers were utilized in instrument development. Teacher behaviors were written down in the process of replaying the video tapes. Behaviors were recorded on separate index cards and the cards grouped to formulate categories and subcategories of behaviors. Through repeated trial usage of the resulting tentative category system on video tapes, refinements and gradual elimination of duplications were possible. These processes resulted in the production of definitions and glossaries for each of the categories and subcategories. The
resulting category system was called the Biology Teacher Behavior Inventory. Practice in the use of the instrument by the researchers in preparation for data collection regarding observer agreement resulted in additional refinements to the instrument.

Observer agreement

Fifteen five-minute intervals were selected at random from the tapes utilized in the process of instrument development. These were preserved for collection of data concerning observer agreement. During actual encoding of data, four additional five-minute intervals were selected at random from the data tapes. Observer agreement was checked by using two of these intervals at midpoint of encoding of data and two near the end of the encoding process. Measurement of observer agreement was accomplished by use of the Scott Index of Inter-coder Agreement (1955).

Data collection, encoding, and analysis

Four BSCS teachers and four non-BSCS teachers were invited to participate in data collection during the fall of 1967. All eight teachers invited indicated an interest in participating. Five video tape recordings of one class period duration were made of each of the eight biology teachers.
Encoding of data was accomplished by making a continuous record of teacher behaviors using the Data Record. This was accomplished by recording symbols representing the appropriate category, subcategory, and subdivision. Symbols were recorded in the appropriate columns of the Data Record to denote verbal, congruent, non-verbal, or contradictory behaviors (Appendix C). As long as a given behavior continued, pencil dots were continued under the appropriate symbols at approximately one-second intervals. Preliminary condensation of data was accomplished by the identification of the predominant behavior on the basis of time consumed within ten second intervals of time.

Compilation of data for each teacher, for BSCS teachers, and for non-BSCS teachers, was accomplished by use of the Master Data Record (Appendix D). In addition to a descriptive analysis of the data on the basis of percentages, non-parametric statistical tests of correlation and significant difference were applied to the data in an attempt to discern similarities and differences among individual teachers and between the BSCS teachers and the non-BSCS teachers.
CHAPTER II

REVIEW OF RELATED LITERATURE

Much literature relates in some way to teacher behavior, although it may be considered that teacher behavior research is still in an embryonic stage of development. Medley and Mitzel (1963a, pp. 247-297) have reviewed numerous of the pertinent early studies including sections on pupil participation and effective teacher behavior. Among the early studies discussed are those of Horn (1914), Puckett (1928), Barr (1929), and Wrightstone (1934).

The studies of Horn and Puckett are of some interest here primarily because early twentieth century evidence is provided regarding objective records of classroom behavior (concerning primarily pupils, in these cases). Various symbols were used as a shorthand way of recording specific pupil behaviors exhibited. The system of Wrightstone, on the other hand, utilized a code which related individuals and the class in interaction with the teacher. Coded teacher behaviors were entered on a class seating chart. Medley and Mitzel considered the categories of Wrightstone more
sophisticated than those of Horn and Puckett, but the technique as much more difficult (1963a, pp. 255-256).

Although the study of Barr pertained to teacher effectiveness as judged by supervisors, it is pertinent here as an early study that focused attention on teacher behavior patterns. A tremendous amount of data was collected including such aspects as teachers' comments on pupils' responses to questions, methods used for motivating pupils, organization of subject matter, types of assignments, amount of time the teacher talked, length of questions and of responses, number of class questions, number of hands raised, number of pupil volunteer contributions, proportion of pupils participating in the discussion, and types of questions asked. It has been considered that this was an exhaustive study which was badly needed, but that much of the data was of no possible use as presented (Medley and Mitzel, 1963a, pp. 258-260).

In the remainder of this chapter, the research literature closely related to this study is discussed in two sections. The first consists of a review of selected studies considered by the writer to be representative of the many studies that pertain to teacher behavior and to teacher-pupil interaction. Attention has been limited to studies based on direct observation or recording of
behaviors and interaction and those studies directly involving observational instrument development or use. Some studies included deal almost exclusively with verbal behavior, others include both verbal and non-verbal behavior, and the study of Galloway (1962) focuses attention on non-verbal aspects. Within the first section, the studies have been grouped into several areas of emphasis.

In the second section, attention is focused on studies pertaining to the behavior of science teachers with an emphasis on biology teacher behavior studies. Studies considered here are not limited to those based on direct observation and recording procedures.

In both sections, some studies considered incorporate also attempts to deal with teacher effectiveness. In relation to this study, the concern of these studies with teacher effectiveness is entirely incidental; their consideration here is based on certain concerns with the development or use of instruments for the description of classroom behavior.

Representative Teacher Behavior and Classroom Interaction Studies

Social processes and classroom climate

Studies pertaining to observable contacts of teachers with kindergarten children have been reported by Anderson and Brewer (1945).
An observation form with names of the children at the tops of vertical columns and names of categories of teacher contacts on horizontal rows was used. This blank provided space for five minutes of observation. The following twenty categories of teacher contacts were included in the form:

1. Determines a detail of activity or act for the child in carrying out a detail.

2. Direct refusal.

3. Relocating, reseating, or placing children in different relation to each other or to property, i.e., different from the relation which the children have themselves selected.

4. Postponing, slowing up the child.

5. Disapproval, blame, or obstruction.

6. Warning, threats, or conditional promises.

7. Call to attention or to group activity.

8. Rations material.


15. Perfunctory question or statement.

16. Approval.

17. Accepts difference.

18. Extends invitation to activity.
19. Question or statement regarding child's expressed interest or activity.

20. The build-up.


22. Sympathy.

23. Permission.


The first eight categories were considered dominative contacts; the last nine were regarded as integrative. Categories nine and ten were regarded as ambiguous, though category nine was judged more nearly dominative and category ten more nearly integrative (Anderson and Brewer, 1945, p. 24).

In the principal study pertaining to variability of teachers' behavior toward children, observations were made in the morning and afternoon at two schools. Some objectives of the study were to obtain information on the total number of contacts of teachers with kindergarten children in a given period of time, to compare contacts, to obtain information on the nature of contacts at different times of the year, and to ascertain whether measures of teachers' integrative and dominative contacts would show differences which trained observers thought could be detected subjectively (Anderson and Brewer, 1945, pp. 43-44).
Observer reliability was determined by having the two observers record simultaneously the contacts of a given teacher. This was done at the beginning of the study and again in the spring (Anderson and Brewer, 1945, p. 46). Anderson and Brewer report correlations from .85 to .93 for dominative contacts and from .74 to .81 for integrative contacts (1945, p. 105).

It was reported by Anderson and Brewer that dominative group contacts exceeded integrative group contacts in mean frequency without exception. Furthermore, it was found that teachers were without exception more dictatorial than democratic and that group domination frequencies were higher in the afternoon than in the morning. In one of the schools, individual domination was greater than individual integration although at the other school, the opposite finding was reported. Significant differences in domination were reported for different times of the school year. Individual contacts were higher in the morning than in the afternoon. All four teachers showed a greater tendency to dominate boys than girls (Anderson and Brewer, 1945, pp. 105-108).

Withall (1949, 1951) attempted to assess the social-emotional climate in a learning situation on the basis of teacher behavior by categorizing teacher statements. Typescripts were used
in the development of the instrument and teacher statements were described in some detail. It was assumed that teacher verbal behavior adequately represented total behavior (Withall, 1949, p. 349). In this manner, twenty-five different kinds of teacher statements were identified. By additional analysis and use of the categories on sound recordings, an attempt was made to achieve mutually exclusive categories (Withall, 1951, pp. 95-96). As a result of this regrouping, the instrument was finally comprised of seven categories pertaining to teacher statements. These were given by Withall as:

1. Learner-supportive statements or questions,
2. Acceptant or clarifying statements or questions,
3. Problem-structuring statements or questions,
4. Neutral statements evidencing no supportive intent,
5. Directive statements or questions,
6. Reproving, disapproving or disparaging statements or questions,
7. Teacher-supportive statements or questions.

Categories 1, 2, and 3, were considered learner-centered, 4 was neutral, and categories 5, 6, and 7, were identified as teacher-centered. Withall reported that as few as fifty statements differentiated between climates (1951, pp. 96-98). Considerable attention was given to validation of the instrument in this study. Withall concluded that the instrument measured "real dynamic factors" (as opposed to merely a set of useful, descriptive terms) on the basis of three correlates: (1) the
relation of learner-centeredness and teacher-centeredness to Anderson's Integrative-Dominance Ratio, (2) pupil reaction on a series of seven questions, (3) observer rating of teacher statements from certain typescripts according to the instrument (1951, pp. 98-100). In addition, an experimental class situation was devised by the categorizer with descriptions pertaining to teacher-centeredness and learner-centeredness. Four observers were utilized. In addition, pupils gave perceptions of positive and negative feelings.

Withall used the *Climate Index* on seventh, eighth, and ninth grade classes in the areas of mathematics, social science, art, and Latin. Seven-minute samples were randomly drawn from the classes and the sound records were typed. Patterns of statements were thus obtained through use of the *Climate Index* and patterns for particular teachers were interpreted. A similar approach was used in a graduate seminar and a counselor-training program (Withall, 1949, pp. 356-358).

The conclusions of Withall that are of major interest here were the following:

1. Climate can be assessed and described.
   
   3. A valid measure of social-emotional climate of groups is obtainable through a categorization of teacher-statements.
5. Different patterns of verbal behavior used by several teachers can be identified.

6. Statements categorized by the climate index as likely to produce "positive" feelings tend to be similarly categorized by impartial observers and tend to be reacted to with "positive" feelings by the individuals to whom they are addressed.

7. Statements categorized according to the climate index as likely to produce "negative" feelings tend to be similarly categorized by impartial observers and tend to be reacted to with "negative" feelings by the individuals to whom they are addressed (1949, pp. 358-360).

Considerable additional experimentation and analysis based on Withall's Climate Index were carried out and reported on by Medley and Mitzel. Included in modifications to the Withall technique were incorporation of non-verbal expressive behaviors as "hostile" and "supportive" and a recombination of categories (Medley and Mitzel, 1963a, pp. 267-269). Furthermore, Medley and Mitzel have reported that the Observation Schedule and Record (OScAR) was evolved in part from the work of Withall and the results of tryouts of his technique (1963a, p. 279).

Bales (1950) reported considerable work with small groups in which he indicated his interest in developing a body of theory relevant to analysis of small groups as well as full-scale social systems. He thus set out to develop a "general purpose, standard
set of categories for observation and analysis" (1950, pp. ii-iv).

Instrument development began in 1946. Bales studied various small groups including a seven-member diagnostic council, basic skills training groups of a training laboratory in group development, and a laboratory seminar. Bales reported eleven or twelve major revisions over a period of time. In the process, he also developed an Interaction Recorder, a mechanical device which he reported simplified the problem of recording (1950, pp. vi-viii).

The categories of the system which Bales developed were the following:

1. Shows solidarity; raises other's status; gives help, reward.

2. Shows tension-release; jokes, laughs, shows satisfaction.

3. Agrees; shows positive acceptance; understands, concurs, complies.

4. Gives suggestion, direction, implying autonomy for other.

5. Gives opinion, evaluation, analysis; expresses feeling, wish.

6. Gives orientation, information; repeats, clarifies, confirms.

7. Asks for orientation, information, repetition, confirmation.

8. Asks for opinion, evaluation, analysis, expression of feeling.

10. Disagrees; shows passive rejection, formality; withholds help.

11. Shows tension; asks for help, withdraws out of field.

12. Shows antagonism; deflates other's status; defends or asserts self (Bales, 1950, p. 9).

The first three categories were considered to comprise a positive social-emotional area, categories four through nine constituted a neutral task area, and the last three categories made up a negative social-emotional area. In addition, Bales specified the various categories as pertaining to problems of communication, evaluation, control, decision, tension reduction, and reintegration (1950, p. 9).

Cornell, Lindvall, and Saupe (1952) were interested in characteristics of schools responsible for variation in school systems. In the study under consideration here, the focus of attention was on characteristics of schools which could be observed in the classroom. The specifications for selection of dimensions were: (1) Comprehensiveness, (2) Significance, (3) Objectivity, (4) Persistence, (5) Validity, (6) Reliability. "Significance" referred to the desire for educationally meaningful dimensions, and "Persistence" was used in reference to the desire for sensitivity to characteristics of
pertinence through time. "Comprehensiveness" pertained to their desire for a broad measure of a classroom as opposed to a limited aspect such as teacher personality. It was hoped that a picture of the classroom learning situation could be obtained through means that would be sensitive to changes in the learning situation in time (Cornell, 1952, pp. 11-19).

The dimensions finally selected for use in the instrument were: (1) Differentiation, (2) Social Organization, (3) Initiative, (4) Content, (5) Variety, (6) Competency, (7) Climate-Teacher, (8) Climate-Pupil. "Differentiation" referred to provisions for individual differences among students, "Social Organization" had to do with group structure and interaction patterns, and "Initiative" dealt with the degree of pupil freedom and pupil planning. "Content" pertained to what should be taught and how it should be organized, "Variety" dealt with activities and techniques, and "Competency" referred to the technical performance of the teacher in the classroom. The two climate dimensions pertained to classroom social-emotional climate (Cornell, 1952, pp. 20-23).

Each of the dimensions included a number of codes briefly defined in the instrument (Classroom Observation Code Digest) and more fully discussed in a manual for observer training purposes. A
form (Classroom Observation Schedule) was provided for scoring purposes (Cornell, 1952, pp. 51-71).

Recording of data was accomplished by noting the appropriate code number (for classroom activities and behaviors observed) under "Differentiation," "Social Origin," "Pupil Initiative," "Content," and "Variety" for each five-minute interval of time. The codes for "Competency" and "Classroom Climate" were given also in terms of positive and negative so they were checked off by number in either the positive or negative column (Cornell, 1952, pp. 27-28). Medley and Mitzel pointed out that evolution of the OScAR was in part based on the items of this instrument (1963a, p. 279).

Six observers used the observation instrument in each of thirty-two classrooms. Sixteen of the classrooms were from a suburban-metropolitan school system and the other sixteen were from a rural-urban system. Classrooms from the fourth, sixth, eighth, and tenth grade levels were randomly selected. With exception of the dimension "Climate-Teacher," all dimensions were reported to reflect differences of school systems. Seven of the dimensions also reflected differences of grade component among classes (Cornell, 1952, pp. 30-37).

Reliability scores were given for each of the dimensions in terms of single observer's measurement and in terms of a team's
measurement (Cornell, 1952, p. 37). Medley and Mitzel have taken the position that these scores would better be called coefficients of observer agreement since they are estimates of correlations between scores assigned by two different observers to the same performance. They report also some work which they did in New York City using a modification of the Cornell technique in which attention was given to both observer agreement and reliability coefficients. The latter were obtained by correlating twenty-five minute records made by different observers at different times (Cornell, 1952, pp. 276-277).

Medley and Mitzel (1963a) developed the Observation Schedule and Record (OScAR) for use by classroom observers. Forty-four activities of teachers and pupils were used. The instrument was divided into: (1) an Activity Section, (2) a Grouping Section, (3) a Materials Section, (4) a Signs Section, (5) a Subject Section. The "Activity Section" was made up of teacher and pupil behavior, the "Grouping Section" dealt with large and small groups, the "Materials Section" incorporated instructional materials used, the "Signs Section" pertained to classroom climate, and the "Subject Section" pertained to areas of instructional activity. The dimensions of classroom behavior studied were: (1) Emotional-social environment, (2) Emphasis on verbal learnings, (3) Social structure (Medley and Mitzel, 1963a, pp. 278-283).
Medley and Mitzel stated that the OSCAR was designed to permit recording of as many "possibly significant" aspects of what is going on regardless of relationships to dimensions or scales (1963a, p. 280). The objective was to observe and record as much of it as possible without assumptions regarding importance or relevance to dimensions.

Recording with this instrument was accomplished over five-minute intervals. Non-verbal behavior was considered, in addition to general areas outlined above, in terms of facial expressions and body movements and primarily as to whether hostile or approving. Observations were made of forty-nine beginning elementary school teachers (grades three to six) among nineteen schools. No attempt was made to control the type of activity observed. According to Medley and Mitzel a principal defect in the OSCAR was its failure to get at any aspect of classroom behavior related to pupil achievement of cognitive objectives (1963a, p. 286).

Scores obtained by use of the OSCAR were considered to account for some of the differences in teachers with respect to rapport with pupils and principals' judgments but not with respect to differences in ability to help pupils learn (Medley and Mitzel, 1963a, p. 283). A more detailed description of the development and use of the OSCAR by Medley and Mitzel and other studies using
the OSCAR has been provided by Medley and Mitzel (1963a, pp. 278-286).

**Characteristics and needs of teachers.**

Ryans (1960) developed an observation instrument with an approach utilizing bipolarities of which eighteen dealt with teacher behavior and four with pupil behavior. A seven-point scale was used by observers for each bipolarity, and an extensive glossary of specific behaviors was set up and utilized in relation to the twenty-two broader bipolarities or behavior dimensions. The instrument was called the *Classroom Observation Record*. The study was sponsored by the American Council on Education and was supported by The Grant Foundation (Ryans, 1960, p. 368).

The observers used were highly selected and trained in the use of the *Classroom Observation Record*. In the selection of observers, attention was given to such factors as ability to attend and perceive, familiarity with teacher behavior, interest in analysis and assessment, and ability and willingness to set aside personal biases for an objective approach to teacher behavior study (Ryans, 1960, p. 92). Training was accomplished by means of a series of practice sessions followed by critical evaluation and comparisons of results.
This was continued until coordination of the trainee and a senior observer reached about .80 (Ryans, 1960, p. 381).


In using the Classroom Observation Record, the observer noted the specific behaviors of a teacher in relation to those in the glossary, then summarized these in relation to the various given dimensions. The complete record of a teacher was comprised of two observations of each teacher, these being made at different times by different observers. Where significant differences in assessments of a teacher behavior pattern were seen to occur, a third observation by a third
independent observer was carried out (Ryans, 1960, p. 382).

Ryans reported that as a result of statistical analyses of the data, the following three interdependent patterns of teacher behavior were suggested:

TCS Pattern X—warm, understanding, friendly vs. aloof, egocentric, restricted teacher behavior.

TCS Pattern Y—responsible, businesslike, systematic vs. evading, unplanned, slipshod teacher behavior.

TCS Pattern Z—stimulating, imaginative, surgent, vs. dull, routine teacher behavior.

It was also found that among elementary school teachers, the Patterns X, Y, and Z were more highly intercorrelated and more highly correlated with pupil behavior in the teachers' classes than was the case among secondary school teachers studied (Ryans, 1960, p. 383).

Travers and associates (1961) carried out a research project designed to discover the relationship between various needs of teachers as measured and related categories of observed elementary teacher behavior. For the appraisal and recording of teacher behavior, a modification of the Withall technique for classifying teacher verbal behavior was used. In addition, a rating scale was developed on which observers could assess certain characteristics of teacher
classroom behavior including four needs described as achievement, affiliation, recognition, and control (Travers, 1961, pp. 7.01–7.03).

It is of some interest to note that Travers reported a negative correlation between the control and affiliation dimensions of the rating scale. A negative correlation was also found between achievement and affiliation measures derived from ratings. Through a process of Q-sorts and factor analysis on various items in the rating scale, five factors of some strength were reportedly found:

1. Factor 1, Warm permissive—Cold, controlling.
2. Factor 2, Quiet controlled, dull—stimulating, active.
3. Factor 3, High ego strength—Low ego strength.
4. Factor 4, Spends much time alone—Little time alone.
5. Factor 5, Little concern with academic achievement—Much concern (Travers, 1961, pp. 7.03, 7.04, 7.11).

The writers reported some consistency on given variables as measured according to teacher statements and as based on ratings. They suggested, however, that modifications of the Withall technique as a measure of teacher behavior would be necessary in some respects. They stated that scores obtained were not independent of each other and that some aspects of teacher behavior were not satisfactorily measured by this technique. It was suggested that affiliation behaviors of teachers should in the future be studied through various non-verbal behaviors rather than on the basis of records of teacher statements only (Travers, 1961, pp. 7.10–7.11).
Teacher effectiveness

The principal purpose in Jayne's study was to seek a relationship between observable teacher activities and changes in pupil performance (1945, p. 101). Nevertheless, the design of the study and some aspects of instrument development are of interest here.

A check-list of activities was developed by Jayne incorporating items from the literature. This check-list of 184 items was then organized into sections. In subsequent refinement, many of these items were dropped because of infrequent occurrence. In the analysis phase of the study, the frequency of each activity was determined (Jayne, 1945, pp. 111-112).

Jayne studied ten classes which were experimentally set up to be taught under attempted identical conditions. Pupils were of the sixth grade and junior high school level in Central State Teachers College Training School at Stevens Point, Wisconsin. Each of the ten classes was taught by a different teacher and the lesson to be taught was the same with respect to topic. The teachers were briefed by Jayne regarding the objectives to be met by the lesson. Procedures used by the teachers were controlled with respect to time spent on introduction, use of references, and recitation. The introduction and recitation were recorded and transcriptions were made.
from the tape recordings (Jayne, 1945, pp. 104-108). A large portion of the report itself pertained to measurement of student gains, correlations of teacher activities with student gains, and reliability and validity of supervisory ratings. In general, Jayne found little relation between specific teacher acts and pupil gain, but that composite scores could be constructed from specific items, these showing correlation with outcomes (1945, pp. 133-134).

Morsh (1956) conducted a study in which the principal objective was to develop an objective instrument for the observation of instructors and students. The major study was carried out at Sheppard Air Force Base, the observers being senior airmen. One hundred twenty instructors were observed by three observers (simultaneously) for one-half hour (Morsh, 1956, pp. 1, 5-7).

By means of exploratory observations, civilian and airmen observers prepared a tentative Instructor Observation Check List which consisted of 160 items. This was refined through use, application of certain criteria, and reliability studies, three checklists being developed. The three checklists were designed to be used simultaneously by three observers (Morsh, 1956, pp. 2-5). In final form, the Instructor Verbal Behavior Observation Check List consisted of thirty items, the Instructor Non-Verbal Behavior Observation
Check List consisted of twenty-eight items, and the Student Behavior Check List involved thirty-one items. Of these, the first twenty-one were identical, being general and of a descriptive nature. Included, for example, were physical characteristics of the classroom. The remaining items were unique to each checklist and allowed for six five-minute intervals of observation (Morsh, 1956, pp. 13-15).

Considerable attention was given to "observer reliability" and "reliability of instructor behavior" in the process of instrument refinement. Morsh reported that only twenty per cent of the items on the original checklists were behaviors of instructors and students that could be reliably observed (1956, pp. 11, 16-24). Medley and Mitzel have pointed out that it is quite possible that many important items were eliminated from this instrument on the basis of the observer agreement requirement (1963a, p. 263). A considerable portion of the report pertained to student gains, student ratings, and supervisory ratings. Intercorrelations among various behavior items and correlations between behavior items and gains and ratings were given (Morsh, 1956, pp. 7-11).

In a study growing out of the Utah State Merit Study Committee Investigation of problems involved in the merit rating of teachers, Hughes (1959a, 1959b, 1963) developed the Code for the Analysis of
Teaching. Hughes stated that it defined the functions performed by the teacher. According to Hughes, the purposes of the study were the following:

1. To find differences in pattern of acts performed by elementary teachers judged as good.
2. To find out which teaching acts are more frequent among good teachers than the others.
3. To find what differences in teacher behavior exist among various teaching situations.
4. To find what teaching acts stimulate "use of higher mental processes, personal involvement, and creativity" in children.
5. To learn about the child's view of the teacher-learner situation.
6. To learn about good teaching and the rationale of a model of good teaching (1959a, pp. 2-3).

The teachers selected for the study were observed three times for thirty minutes each. Records were made by two observers who focused primary attention on teacher verbal behavior (Hughes, 1959a, p. 11). Attention was given to teacher verbal behavior, teacher non-verbal behavior to the extent that Hughes considered that it could be reliably obtained, and the response of the child or
group (1963, p. 26). The concepts of teacher power and teacher responsiveness provided the basis for the categories used in the Provo Code (Hughes, 1963, p. 28).

The description of teaching was then attempted in terms of the functions performed by the teacher in the classroom. Hughes stated that the functions were then classified as patterns of dominative, integrative, or neutral behavior on the basis of Anderson's study in order to develop a concept of "good" teaching (1959a, pp. 4-5).

The instrument (called the University of Utah Revision of the Provo Code) contained seven categories of functions comprising thirty-three functions in all. The categories of functions given were: (1) Controlling Function, (2) Imposition of Teacher, (3) Facilitating Functions, (4) Functions that Develop Content, (5) Functions that Serve as Response, (6) Functions of Positive Affectivity, (7) Functions of Negative Affectivity. The first two categories and the seventh one were classified as dominative, the third as neutral, and the fourth, fifth, and sixth as integrative (Hughes, 1959a, pp. 11-12).

Hughes reported that most teachers rely heavily on dominative functions, stating that the major functions performed were those of control (over forty per cent of all acts for most teachers). Control
was reported as most predominant with respect to what the child should do and how he should answer (Hughes, 1959a, p. 7). It should be added here that Hughes stated that the structuring of the problem or designation on the part of the teacher of the content to which the students were asked to give attention was included in the definition of control (1963, p. 32). Of the forty-one teachers studied, eighty per cent were reported to be dominative in over fifty per cent of the teaching acts in the classroom.

Other findings given were that all teachers studied were found to be more positive than negative, but that responsiveness of teachers to replies of children in such forms as elaboration, generalization, summarization, and stimulation was infrequent. This was true regarding responsiveness both in dealing with content and on a personal basis. It was reported that simple memory and recall was the nearly exclusive mental activity requested under control conditions. Choice, exploration of ideas, analysis of personal experience, problem solving, and spontaneous reaction by children were seldom found, or, if found, were often not accepted by the teacher. It was further reported that the teacher seldom functioned as mediator of the culture, and that a surprisingly small proportion of the teaching acts were "Functions that Develop Content." Less than
20 per cent of all teaching acts were recorded in this category on 75 per cent of the records (Hughes, 1959a, pp. 7-10).

In general, it was reported by Hughes that teachers' behavior patterns were very similar and that differences found were contributed by relatively few teachers (1963, p. 34).

Studies with cognitive orientation

Smith (1960, 1961, 1962, 1966) approached the matter of teacher behavior from the standpoint of a pedagogical model in which the teacher's actions were considered the independent variables. These operated through various processes, according to Smith, which were connected to the behavior of pupils, the dependent variables. He considered that teacher behaviors were linguistic, performative, and expressive and that teaching acts consisted largely in verbal behavior (Smith, 1966, pp. 233-237).

Verbal behaviors were classified by Smith as "Logically relevant," "Directive," and "Admonitory." Non-verbal behaviors were considered as "Performative" or "Expressive." "Performative" behaviors were considered to have a purpose (such as to show or tell something); "expressive" behaviors were not purposeful nor addressed to anyone though they functioned in teaching (Smith, 1966, pp. 236-240).
The study of Smith has been identified by Medley and Mitzel as the first study of logic in classroom discourse. Data were collected by means of tape recorder supplemented by notes made by an observer. Eighty-five class sessions, seventeen high school teachers, and five communities were involved as sources of data. A major concern was the preparation of a set of categories for classification of opening phases of episodes (verbal exchanges between two or more speakers). The categories given were: (1) Defining, (2) Describing, (3) Designating, (4) Stating, (5) Reporting, (6) Substituting, (7) Valuating, (8) Opining, (9) Classifying, (10) Comparing and Contrasting, (11) Conditional Inferring, (12) Explaining, (13) Directing and Managing Classroom (Medley and Mitzel, 1963a, pp. 268-288).

Wright (1959, 1960) developed an instrument for study of secondary school mathematics classrooms, the behaviors given consideration being primarily those of verbal interaction. Wright stated that the categories which formed the basis of the instrument were related to selected general aims of mathematics teaching. The categories were considered to fall naturally into three frames of reference: (1) Ability to Think, (2) Appreciation of Mathematics, (3) An Attitude of Curiosity and Initiative. Each verbal behavior was
identified with all three frames of reference, if possible, and classified in a category of each (Wright, 1959, pp. 103-106). The categories under "Ability to Think" were (1) Analyzing, (2) Synthesizing, (3) Specializing, (4) Generalizing. The categories under "Appreciation of Mathematics" were: (1) Methodology, (2) Subject Matter, (3) Other Fields and Areas, (4) Historical Significance. "Curiosity" and "Initiative" were the only categories in the third frame (Wright, 1959, pp. 104-105).

The study was carried out in twelve algebra classrooms in secondary schools of Metropolitan St. Louis. A special time-sampling technique was used in which alternate fifteen-second intervals were observed with recording being carried out in the intervening alternate intervals. Wright stated that the fifteen-second interval was supported on the basis of a comparison of behaviors which yielded a "defined natural division of verbal interaction" (1959, pp. 106-110, 120).

Considerable attention was given to the level of observer agreement in classification of behaviors. This was done with respect to the level of agreement between observers in single units of classroom behaviors and the level of agreement reached by repeated observation of a single unit by the same observer (Wright, 1959, pp. 111-113, 116).
Wright compared various categories of teacher behaviors and pupil behaviors between the Algebra 1 and Algebra 3 classes studied. He reported that only two of the twenty-one categories of teacher behaviors and one category of pupil behaviors showed significant differences at the probability level of .05. An additional general finding was that five teacher behaviors occurred to every two pupil behaviors (Wright, 1959, p. 117).

Wright's instrument as described above was later substantially modified in collaboration with Procter. Medley and Mitzel have suggested that the high level of training in mathematics and behavior observation required of the observers are problems emerging from the study of Wright and Procter (1963a, p. 290).

Taba (1964, 1965) concerned herself with thought processes of pupils and appropriate teaching strategies. The study was oriented toward the cognitive domain and verbal behavior. Furthermore, teacher behavior was considered effective or ineffective in terms of a theoretical construct of concepts of the cognitive tasks and principles governing the development of cognitive skills. Nevertheless, the instrument developed and some of the results are of some interest and relevance to this study. Twenty classes were utilized and each was taped four times. Tapings were planned
in such a manner as to incorporate particular kinds of activities.

Instead of time sampling, Taba reported using the "thought unit,"
which she defined as a remark or series of remarks expressing an
idea, serving a function, and classifiable according to a level of
thought (1964, p. 529). Verbal transactions received three ratings:
(1) Designation, (2) Function, (3) Levels of Thought. "Designation"
included "child gives," "child seeks," "teacher gives," "teacher
seeks." "Function" ratings were considered by Taba as: (1) Psycholog-
ical or managerial and unrelated to content, or (2) Giving direction
to discussions but which can also be rated in relation to content.

"Levels of Thought" pertained to student and teacher verbal behavior
and included a rating scheme for three cognitive tasks. The three
cognitive tasks used in the rating scheme were: (1) Grouping and
labeling, (2) Interpreting information and making inferences, (3) Pre-
dicting consequences (Taba, 1964, pp. 529-531). In addition, four
groups of function rating were given by Taba as important for describ-
ing the effect of teaching strategy on thought levels. They were:
(1) Focusing, (2) Extending the thought on the same level, (3) Lifting
thought to a higher level, (4) Controlling thought. Also incorporated
were means for handling shifts in subject matter, bringing the dis-
cussion back to the original topic, and wandering from the subject
(Taba, 1964, p. 531). Information was recorded by using a coding system for the various aspects mentioned above.

Taba reported finding that when a teacher attempted to raise the level of thought early in the discussion, pupils tended to return to a lower level. She reported also that when teachers repeatedly attempted to steer discussion to the inferential level without development of a body of needed information, pupils often returned to the information level. Also, it was reported that when there was a constant change of focus, pupils' thoughts tended to alternate among levels, stabilizing on the most primitive one. She stated that the level of thought attained seemed to be determined not by a single teacher act but by the entire pattern of transactions (Taba, 1964, p. 533).

Miller (1964) studied teacher behavior in relation to pupil thinking. Specifically, he was concerned with whether highly directive teaching was accompanied by less educative pupil reactions than learner-responsive teaching. Differences in pupil opportunity based on teacher comments were recorded along a "Responsive-Directive Scale." Pupil comments were recorded in terms of recognition or recall and three levels of inference, error, and procedural comments.
The data thus obtained were based on seventh and eighth grade pupils in staged American Economics lessons. Each of four teachers taught one group of students in a more directive manner and another group in a more responsive manner. Audio tape recordings of classroom teaching were made and typescripts were prepared.

Miller found highly directive teaching accompanied by largely recognition and recall by students. Responsive teaching was generally accompanied by higher levels of student understanding and greater pupil error. No major difference in mastery of facts or level of understanding (as measured by an objective achievement test) was reported. Within the framework of the study, Miller concluded that responsive teaching was more effective than directive teaching (1964, pp. 227-228).

Verbal interaction, communication, and linguistic behavior

Interaction analysis was devised by Flanders (1960, Amidon and Flanders, 1963) as a system of analyzing the verbal interaction of teachers and pupils. All statements that occur in the classroom were identified with one of three major sections: (1) Teacher Talk, (2) Student Talk, (3) Silence or Confusion (Amidon and Flanders,
The three sections were comprised of ten categories for assessing the direct and indirect influence of teachers; seven pertained to teacher statements, two to pupil statements, and the other one to silence or confusion. In brief, the categories were given as follows:

1. Accepting feeling constructively.
2. Praising or encouraging.
3. Accepting or making use of student's ideas.
4. Asking questions.
5. Lecturing.
7. Criticizing.
8. Student responding to teacher.
9. Student talk initiated by the student.
10. Silence or confusion (Amidon and Flanders, 1963, pp. 5-11).

The procedure for recording of information was to record the appropriate category number for verbal interaction observed in the classroom every three seconds. These numbers were recorded in sequence, thus providing long columns of numbers. Classification ceased when classroom activity was inappropriate for observation (when no verbal interaction occurred). Furthermore, when more
categories than one occurred in a given three-second interval, they were all recorded. If no change occurred, the same category was recorded in successive intervals (Amidon and Flanders, 1963, pp. 13, 23, 26).

Some information about sequence of behavior was retained in this method since tallies were written in order in a column. The matrix was set up in such a manner that tallies in given areas of the matrix provided information of particular kinds (Amidon and Flanders, 1963, pp. 26-37).

Flanders and Amidon defined indirect teachers as those using considerably more than the average amount of indirect influence (given as categories 1, 2, 3, and 4, in the instrument). Teachers using much more than the average amount of direct influence (categories 5, 6, and 7) were regarded as direct. Flanders and Amidon reported that "Accepts Feeling" was used very rarely (less than .5 per cent of the time) and that there was little difference in its use between direct and indirect teachers. "Praises or Encourages" was used about 2 per cent of the time by both types of teachers. "Accepts or Uses Ideas of Students" represented about 2 per cent of the tallies of direct teachers and 9 per cent of indirect teacher statements. "Asks Questions" and "Lecture" revealed little
difference between direct and indirect teachers. "Asks Questions" accounted for about 8 to 15 per cent of the teacher talk while "Lecture" constituted 25 to 50 per cent of the verbal behavior of teachers. "Gives Directions" was reported to be used by direct teachers about 8 per cent of the time and by indirect teachers about 4 per cent of the time. Direct teachers were also reported to use "Criticizes or Justifies Authority" more (about 5 per cent of the time) than indirect teachers (less than 1 per cent). For the direct teacher, about 50 per cent of the tallies of "Student Talk-Response" were reported to be answers to teachers' questions. This compared to about 30 per cent for indirect teachers. In "Student Talk-Initiation" more sustained student talk was reported in classes of indirect teachers than direct teachers. "Silence or Confusion" was reported to be more heavily loaded for direct teachers than indirect teachers (Amidon and Flanders, 1963, pp. 12, 38-41).

Flanders has also done considerable work using this system on teacher influence in the classroom and relationships to pupil achievement and attitudes (1963, 1964, 1965). A more detailed description of these aspects of Flanders' studies and other studies using the Flanders' system of Classroom Interaction Analysis has been made by Pankratz (1966).
Lewis, Newell, and Withall (1961) described studies which they regarded as rather specifically oriented toward the view of classroom interaction as a process of communication acts. Lewis reported a desire for descriptive categories minimizing inference but inclusive enough to incorporate any communication act in the classroom. The Interaction Process Analysis of Bales was modified for desired finer discriminations and the instrument was tested using two small experimental classes (Lewis, 1961, p. 21).

In using this system, the observer judged the dominant intent of the initiator of communication over a ten-second interval of time. If shifts in inferred intent occurred within the ten-second interval, additional category scores were added as necessary. The categories to be applied in the process of communication were:

1. Asks for Information
2. Seeks or Accepts Direction
3. Asks for Opinion or Analysis
4. Listens
5. Gives Information
6. Gives Suggestion
7. Gives Direction
8. Gives Opinion
9. Gives Analysis

10. Shows Positive Feeling

11. Inhibits Communication

12. Shows Negative Feeling

13. No Communication

14. Perfunctory Agreement or Disagreement
   (Lewis, 1961, pp. 212-215)

The two courses studied were at the graduate level at the University of Wisconsin. One was taught by the "case-study" method; the other by the "student-centered" method. Various specific differences in behaviors of the instructors were reported as a result of the study. Differences in responses of students were considered less marked on the basis of the data. In general, Lewis and associates concluded that the observational categories were useful for discriminations between instructional groups in which different patterns of communication were presumed. Analysis of data by looking at relative use of all categories and comparisons of each category were considered to give interpretations consistent with each other and the intent of the instructors (Lewis, 1961, pp. 215-219).

Bellack and associates (1963, 1965) have studied the teaching process from the standpoint of an analysis of teacher and student linguistic behavior in the classroom. The position was taken that
classroom activities are carried on largely by verbal interaction.

Involved in the study were fifteen teachers and 345 pupils from seven schools in metropolitan New York. All were high school social studies classes. A particular unit of instruction was selected for the study but the manner in which teachers taught was not controlled. Tape recordings and transcriptions of four sessions of each of fifteen classes comprised the basic data (Bellack, 1965, pp. 1-2).

A major intent was to search for the meaning of communication; hence, Bellack looked for pedagogical significance of communication, the content of the statement, and the emotional aspects of the communication. The actions of verbal interplay (called Pedagogical Moves) were classified in four major categories: (1) Structuring, (2) Soliciting, (3) Responding, (4) Reacting. There was also a "Not Codable" category. In essence, structuring moves were seen as moves that set the context for behavior, soliciting moves encourage response, responding moves fulfill soliciting moves, and reacting moves modify or rate previous moves. It was further reported that the concept of teaching cycles (cyclical patterns of combinations of moves) was induced from analysis of data and that this facilitated description of ebb and flow of the teaching process (Bellack, 1965, pp. 4-6).
Meanings represented by the content of communications were categorized as: (1) Substantive (referring to subject matter), (2) Substantive-logical (referring to cognitive processes involved in dealing with subject matter), (3) Instructional (referring to social-managerial aspects), (4) Instructional-logical (referring to cognitive processes related to didactic verbal processes). This last category would involve rating, explaining, and giving directions, for example. Emotional meanings were also characterized but over larger time intervals than pedagogical units, and it was done by eleventh grade students in order to obtain the student point of view (Bellack, 1965, pp. 5-10).

Bellack reported finding impressive similarities among various teachers and classrooms and consistency of individual classes in pedagogical pattern throughout the four sessions. Other results reported were that teachers dominated verbal activities (three to one in lines spoken), and that the pedagogical roles of teachers and pupils were clearly distinguished on the basis of differences in frequencies in each category of pedagogical moves (Bellack, 1965, pp. 16-20). Teachers structured the lesson, solicited responses, and reacted to responses. Pupils mainly responded to solicitations. In total, soliciting, responding, and reacting each accounted for
30 per cent of the moves while structuring accounted for about 6 per cent. About three-fourths of the lines spoken (two-thirds of the moves) pertained to subject matter (Substantive meaning). With respect to "Substantive-logical" meanings, much more fact-stating and explaining was reported than defining and interpreting and opining and justifying. About one-half of the moves (one-fourth of the spoken lines) conveyed "Instructional" meanings. With respect to "Instructional-logical" meanings, fact stating (such as statements about procedures and assignments) was reported to occur most frequently. Teacher directions to pupils were also reported as frequent. With respect to "Emotional" meanings conveyed to students, Bellack reported that teachers tended to be consistent over time (1965, pp. 10-12).

A major intent of Phase II of the studies by Bellack and associates pertained to a more detailed study of the functions of pedagogical moves and their patterns in the teaching cycles. The system was thus modified to incorporate functions and ways of executing functions, resulting in a highly complex system of analysis. Numerous detailed results pertaining to "Soliciting," "Responding," "Structuring," and "Reacting" moves were reported. For example, it was reported that the respondent performed the task expected by the solicitor in 92 per cent of the "Responding" moves.
Bellack (1965, p. 72) reported that "Structuring" moves represented only 5.5 per cent of all moves and three-fourths of these components included announcement of topics to be studied. Almost all topics announced were "Substantive" (Bellack, 1965, pp. 115-116). Most teacher reactions were found to be occasioned by pupil moves and ratings of pupils by teachers were four times more positive than negative (Bellack, 1965, p. 146).

Bellack also presented discussion of results in the form of rules for "The Language Game of Teaching" (1965, pp. 173-184). He considered that these rules defined the game of teaching, not prescriptively but descriptively according to the results of his studies. This was done in the form of general rules, rules for the teacher and pupil regarding "soliciting," "responding," "structuring," and "reacting" moves, and rules for teaching cycles.

Openshaw, Cyphert, and others (1965) undertook to develop a means for describing all observable teacher behaviors. The study was not evaluative but rather undertook to develop and validate instrumentation that could be employed in learning about teaching. The central objective was to develop a system for the classification of teacher classroom behavior (Openshaw, 1965, pp. 1-2).
Systems of classification already in existence were extended through classroom observation and the categories of different systems were integrated. The four major dimensions evolved were:

1. Source of Stimulation, a source dimension,
2. Target of Behavior, a direction dimension,
3. Purpose of Behavior, a function dimension,
4. Mode of Communication, a sign dimension.

The study did not undertake a delineation of learner behavior with the classroom interaction. The writers stated that the source dimension provided an indication of the relationship of student and teacher interaction at a basic level and that teacher reception of student behavior was not classifiable without recognition of the student behavior itself. The study was also restricted to purposeful behaviors. The behaviors categorized, in other words, were those that fulfilled a teaching function, and these were considered the basic components of teacher behavior to be classified (Openshaw, 1965, pp. 3-9).

Each unit of teacher behavior that served a discernable function was termed an "encounter." A given "encounter" was categorized in each of the four dimensions. Any change in the source and direction dimensions indicated a new "encounter," with the function dimension considered critical. A change in the source dimension was considered to be automatically accompanied by a
change in function dimension (Openshaw, 1965, pp. 13-15). The writers of the report indicated that the "Mode of Communication" and the "Purpose of Behavior" are controlled by the "Target of Behavior" which is in turn controlled by the "Source of Stimulation." The "Mode of Communication" and "Purpose of Behavior" were considered to influence each other and the "Target of Behavior" was considered to influence the "Source of Stimulation" (Openshaw, 1965, p. 8). The instrument was constituted of a listing of the four dimensions mentioned above and a presentation of the various behaviors comprising each dimension.

**Non-verbal behavior**

The work of Galloway (1962) constituted an exploratory study pertaining to observational procedures in the study of teacher non-verbal behavior. The study involved the observation of six elementary school teachers and their pupils of the fourth, fifth, and sixth grades. Three independent observational procedures for collection of data were used. The principal objective of the study pertained to the identification of the most useful and valid procedure for gathering data about a teacher's non-verbal behavior (Galloway, 1962, pp. 7-8).
Data were obtained from the non-verbal behavior of teachers through the three observational procedures and from pupils' perceptions of teacher attitudes as assessed by administration of the Davidson-Lang Adjectival Checklist. One of the three observational procedures consisted of the use by trained observers of an observation instrument developed by Galloway in which categories of non-verbal behavior were listed in a continuum pertaining to encouraging-inhibiting communication. In the second procedure Galloway utilized a team of observers (separate from the observers mentioned above) who recorded the non-verbal behavior of teachers in the form of observation records. Three judges read these records and made judgments pertaining to the influence of the teacher behaviors recorded on the observation records. In the third procedure, Galloway utilized experts in leadership, curriculum, and communication who observed teacher non-verbal behavior and assessed it in terms of the encouraging-inhibiting communication continuum (Galloway, 1962, pp. 9-12, 64-79).

The instrument Galloway developed for use in the first observational procedure mentioned was comprised of seven categories: (1) Enthusiastic Support, (2) Helping, (3) Receptivity, (4) Pro Forma, (5) Inattentive, (6) Unresponsive, (7) Disapproval. Under each of
these categories, the subcategories of "Facial Expression," "Action," and "Vocal Language" were given. In the complete instrument, descriptions of each of the categories and subcategories were also given (Galloway, 1962, pp. 65-68, 146-148). It can be quite readily observed that the first three categories pertained to encouraging communication while the last three categories were included in inhibiting communication.

The observers using the instrument were graduate students at the University of Florida who were also experienced elementary school teachers. Two teams of two observers were used. The observers inferred influence and effect of non-verbal communications from the standpoint of the pupil. Observations were recorded in categories, but no attempt was made to record at set time intervals (Galloway, 1962, pp. 68-72).

The second observation procedure was based on narrative observation records. Six thirty-minute observation records were made for each of the six teachers, each record being considered a collection of communicative events or a series of "episodes." Judges evaluated each episode as "Encouraging," "Inhibiting," or "Pro Forma" communication (Galloway, 1962, pp. 73-78).

In the third observation procedure, the selected experts were asked to observe and assess the non-verbal behavior of the teachers,
thus providing a single judgment for each teacher on an encouraging-inhibiting communication continuum (Galloway, 1962, pp. 78-79).

Results from the Adjectival Checklist taken by the pupils of each teacher were condensed to provide a mean score for each pupil and by summing these for all pupils in a classroom, a mean score for each teacher. Thus a comparison of these results with the various observation procedures was possible (Galloway, 1962, pp. 79-82).

Galloway reported consistency of recording by the two teams of observers using the observation instrument significant at the .01 level (with coefficients ranging from .48 to .86). Reliability coefficients for the two teams of observers were reported at .91 and .94 when all observations of the teachers were used. A significant level of agreement was also found for the judges utilizing the second observation procedure but not for the experts using the third observation procedure. Rank order coefficients between data from pupils' perceptions of teacher attitudes and data from each of the three observational procedures were not significant except in the case of the curriculum expert. However, a significant relationship (at the .05 level of confidence) was found between rankings of teachers based on use of the observation instrument and the results of the
judgments of the judges. In addition, Galloway pointed out that
the rank order coefficient between the observation procedure using
the observation instrument and pupils' perceptions of teachers atti-
tudes approached significance as did the coefficient between judges'
judgments and teacher rankings based on observers' use of the ob-
servation instrument. Galloway concluded that the observational
procedures of recording in categories and writing observation records
held promise for further research (1962, pp. 132-136).

Science Teacher Behavior and Classroom Interaction Studies

Kleinman (1965) has done a study pertaining to the kinds of
questions asked by teachers. Her main purposes in this study were
to ascertain the kinds of questions asked by general science teachers,
to determine the relationship to students' understanding of science,
and to determine the relationship to pupil and teacher behavior

The observation form contained seven question categories
and also a listing of bipolar adjectives used in describing teacher
and pupil behavior. Kleinman stated that these four pupil behaviors
and eighteen teacher behaviors were rated on a five-interval scale
from low to high (1965, p. 308). Pupil behaviors given were: (1)
Apathetic-alert, (2) Obstructive-responsive, (3) Uncertain-confident,

Students' understanding of science was measured by use of the Test on Understanding Science, Form Jy. Attention was given to the reliability of observers and the consistency of behavior of each of the teachers observed (Kleinman, 1965, p. 308).

Most of the seventh and eighth grade general science teachers from five school systems were observed (twenty-three teachers in all). These were observed once, then the three high teachers and the three low teachers, in terms of the frequency of critical thinking questions asked, were observed twice more (Kleinman, 1965, pp. 308-309).
Kleinman reported that the high teachers asked fewer questions than the low teachers and that they asked significantly fewer rhetorical and factual questions. The high group asked almost four times as many high-type questions as the low group. It was also reported that teachers who asked more critical thinking questions also asked more neutral, clarifying, and associative questions than the others. Only one value question was asked in the thirty-five observations (Kleinman, 1965, pp. 310-316). Kleinman felt her data revealed a relationship between the use of critical thinking questions and the behavior of pupils, and reported also a trend toward higher behavior ratings for the high teachers. It was also concluded that seventh and eighth grade boys and girls of high ability achieved a better understanding of science under teachers who asked critical thinking questions than under those who did not (Kleinman, 1965, pp. 313-316).

Parakh (1965) carried out an investigation of teacher-pupil interaction in high school biology classes. The principal objectives of the study were to develop a reliable category system for first-hand systematic observation of teacher-pupil interaction in high school biology classes and to describe and analyze the characteristics and patterns of teacher-pupil interaction in those classes (Parakh a, p. 3).
Data were obtained by means of tape recorder and notes (pertaining especially to the non-verbal behavior) taken by the observer. The category system was then developed from notes, tapes, typescripts, and tapescripts. Parakh stated that the theoretical framework underlying his category system was taken from communication theory and social interaction theory. The classroom communication process was seen as giving and seeking information by teachers and pupils (Parakh a, p. 9).

The classroom behavior of the teachers was conceptualized along three inter-related dimensions: (1) Evaluative, (2) Cognitive, (3) Procedural. Other dimensions were: (1) Pupil Talk Dimension, (2) Silence, (3) Not Categorizable. In all, there were forty-five categories and subcategories in the dimensions above. Parakh stated that expressive non-verbal behaviors such as smiles, frowns, grimaces, and gestures were not included except to the extent that they were considered helpful in placing behavior into the categories of the system (Parakh a, pp. 12-15).

The procedure for categorization was to record the number of the category most nearly represented every five seconds. By recording the numbers in rows, some information about sequence was retained. Categorization was accomplished on the basis of pedagogical function or operation rather than on the basis of inferences about
"covert purposes, intentions, motivation, etc. of the speaker or actor" (Parakh a, p. 18).

Parakh reported that the end product of the first phase of his study was a highly reliable category system for first-hand systematic observation of teacher-pupil interaction in high school biology classes (Parakh b, p. 2).

In a second study based upon the study just described and utilizing the instrument developed, Parakh did a description and analysis of teacher-pupil interaction (Parakh b). Aspects studied were: (1) Teacher Talk, (2) Teacher's Non-Verbal Behavior, (3) Pupil Talk, (4) Teacher's Behavior in the Cognitive Dimension, (5) Teacher's Evaluative Behavior, (6) Teacher's Procedural Behavior, (7) Silent Pauses, (8) Patterns of Interaction, (9) Wide Differences in Teacher-Pupil Interaction (Parakh b, pp. 15-22). Parakh reported that the "average or composite" teacher talked about 75 per cent of the total class time. With respect to teacher's non-verbal behavior, the principal result reported was that the "average teacher's pedagogically relevant non-verbal behavior accounted for about 8 per cent of total time in lectures and 37 per cent in labs." (Parakh b, p. 15) Pupil talk addressed to the teacher accounted for 15 per cent of the total time in lectures and 13 per cent in labs. Pupil responses and
information giving constituted 12.4 per cent of the time in lectures and 6.7 per cent in labs (Parakh b, pp. 15-16). Teacher's "Evaluative Behavior" such as praising, encouraging, and accepting student performance and ideas constituted about 7 per cent of the time in lectures and 3 per cent in labs. Parakh stated that pupil questions were seldom if ever praised or encouraged (Parakh b, p.16). It was found that about 18 per cent of the time in lectures and 40 per cent in labs was devoted to "Teacher's Procedural Behavior." Teacher's behavior in the "Cognitive Dimension" constituted an average of 54 per cent of the total class time in lectures and 42 per cent in lab. Information giving constituted 43 per cent and 29 per cent as compared with 11 per cent and 13 per cent devoted to information-seeking. Operations within the "Cognitive Dimension" that received attention were demonstrations, fact stating, explaining, defining, evaluation, asking for facts, asking for explanations, and asking for definitions. He reported that teachers seldom asked pupils to give opinions, hunches, or evaluations (less than 0.1 per cent) and that explicit references to the nature of science were virtually absent. Parakh noted also that problem-solving behaviors occurred infrequently, comprising only about 0.6 per cent of the time in labs and less than 0.1 per cent in lectures (b, pp. 16-19).
Parakh reported that silent pauses made up about 3 per cent of the class time in lectures. Teachers' questions accounted for about 11 per cent of the time in lectures while pauses after the questions accounted for 1.2 per cent of the total time (Parakh b, p. 19).

Patterns of interaction in lecture-recitation classes were found to be constituted mostly of four categories which accounted for 55 per cent of the total interaction. Descriptively, this pattern was as follows: The teacher gave information, the teacher asked a question, the pupil responded briefly, and the teacher accepted the response or indicated that it was correct. Several variations of the above pattern were also reported by Parakh. In laboratory classes, a larger variety of interaction patterns was found, with teacher behavior seen as largely responsive to pupil requests for information and materials. In addition, Parakh reported wide differences in interaction scores among the ten teachers (b, pp. 20–23).

Pankratz (1966) studied verbal interaction patterns in the classrooms of selected physics teachers. Determination of teacher effectiveness was accomplished by completion of the Teacher Rating Scale by the principals, completion of the Student Opinion Questionnaire by the students in one class of each teacher, and completion
of the Teaching Situation Reaction Test by each teacher. The five highest and five lowest ranking teachers according to the above evaluation instruments were then selected for direct observation. The Observational System for Interaction Analysis by John Hough adapted from Flander's system of Interaction Analysis was used to record and classify verbal classroom behavior (Pankratz, 1966, pp. 5-10, 122-123). Categories of verbal behavior were then examined statistically for significant relationship to teacher effectiveness.

The two groups of physics teachers were also examined with respect to differences in aspects such as total interaction pattern, occurrence of questions, and influence patterns soliciting or following students' responses (Pankratz, 1966, pp. 9-10, 15).

From an analysis of the data, it was concluded that teachers in the high sample used significantly more praise and reward and more cognitive skill clarification and acceptance than teachers in the low sample. Teachers in the high sample used significantly fewer requests and commands, less criticism and rejection, and experienced less confusion and irrelevant behavior in their classrooms than did teachers in the low sample. Furthermore, indirect influence was used by the high sample significantly more often and in a significantly more sustained manner than by the low sample of
teachers. The sustained use of students' ideas and the length of teachers' answers to students' questions was also significantly greater for the high sample than for the low sample (Pankratz, 1966, pp. 124-126).

Gold's study (1966) was parallel in time and design to that of Pankratz but focused on a study of biology classrooms. Thus the study gave primary attention to a comparison of behavior in classrooms of biology teachers considered highly effective and those considered less effective. The instrument used was Flanders' Interaction Analysis as modified by Hough (Gold, 1966, pp. 5-8). Hypotheses were stated in terms of such aspects as percentage of time spent in the various categories of behavior of the instrument, ratio of direct to indirect teacher influence and the ratio of these with respect to pupil orientation, and ratio of sustained to transitional classroom behavior. The other hypotheses pertained to the ratio of total direct teacher influence to total student talk and differences in the total interaction pattern (Gold, 1966, p. 9).

When patterns of interaction of the highly effective and less effective biology teachers were statistically tested for significant differences with respect to aspects referred to in the hypotheses, only one of the hypothesized differences was found. Gold reported
that since this was with respect to significant difference in total interaction patterns and through use of the Darwin Chi-square, he examined all cells of the matrices for significant differences, but found none. He thus concluded that there were few differences in interaction as measured between the biology teachers regarded as highly effective and those considered less effective (Gold, 1966, pp. 105-116).

Kochendorfer (1966) studied the classroom practices and teaching rationale of high school biology teachers using various curriculum materials. The determination of classroom practices used by the teachers was accomplished through completion of the Biology Classroom Activity Checklist (BCAC) by the students in one of each of the teacher's classes. The BCAC was designed by Kochendorfer for the purpose of determining the extent to which a teacher's practices conformed to the practices recommended in the BSCS literature and by a panel of persons associated with BSCS as practices contributing to the attainment of BSCS objectives (Kochendorfer a, p. 1).

Three groups of teachers were involved in the study. One group consisted of experienced teachers who were using BSCS for the first time, one group consisted of experienced teachers using
high school biology texts other than BSCS, and the other group was composed of teachers using BSCS materials and having a mean of five years of experience in the use of BSCS materials. Kochendorfer reported that there was a significant relationship between the mean scores of each teacher on the classroom and laboratory portion of the BCAC, and that there were significant differences among the three groups of teachers in terms of BCAC mean scores. He also reported finding a significant relationship between BCAC scores and Attitude Inventory scores as well as between BCAC scores and "adjusted class mean gains" on the Processes of Science Test. The Attitude Inventory was an instrument designed to determine a teacher's attitude toward BSCS rationale. The Processes of Science Test was an instrument designed to determine a student's understanding of the nature of the scientific enterprise (Kochendorfer a, p. 2).

Barnes (1966) studied the nature and extent of laboratory instruction in high school biology classes using various materials. An instrument was developed which was used to identify the degree to which the laboratory activities of the groups under study conformed to the laboratory activities recommended by the BSCS. The groups under study consisted of classes of teachers who had used BSCS for five years, those using BSCS materials for the first time, and classes using non-BSCS materials.
The instrument, called the **Biology Laboratory Checklist** (BLAC), was validated by utilization of items based on statements by individuals who participated in the development of the BSCS program and by having each item verified by a panel of judges who were familiar with the BSCS program. The BLAC was administered to the students in the classes under study.

Barnes found a significant difference among the three experimental groups in degree of conformity of laboratory practices to those laboratory practices recommended by BSCS. He reported also a significant relationship between the degree to which laboratory activities conform to those recommended by the BSCS and the laboratory facilities available. A significant relationship between the degree to which laboratory activities conform to laboratory activities recommended by the BSCS and the degree to which there is teacher acceptance of BSCS objectives was also identified (Lehman, 1967, p. 23).

Gallagher (1967) studied teacher variation in concept presentation utilizing only biology teachers who taught classes of high ability students using the BSCS Blue Version, *Molecules to Man*. All teachers were working in suburban situations and all had some training contact with the BSCS program. Furthermore, the study was focused on the concept of photosynthesis, thus attempting to control possible differences in teacher and student behavior that might be the result of the particular concepts being taught.
Gallagher's study was of a cognitive orientation with emphasis with respect to teacher behavior on such aspects as goals, level of conceptualization, and style of presentation. Goals were considered as either content or skills and the levels of conceptualization defined and studied were: (1) Data, (2) Concept, (3) Generalization. The style was considered to be (1) Description, (2) Expansion, (3) Explanation, (4) Evaluation-justification, (5) Evaluation-matching (Gallagher, 1967, p. 10). In addition, Gallagher studied the number of topics covered by each of the teachers in the area of photosynthesis and nature of the attention paid to the textbook (1967, p. 13).

From an operational standpoint, the data suggested that there was no such thing as a BSCS curriculum presentation in the schools, but rather individual teacher interpretations of BSCS. Gallagher found substantial differences among teachers with respect to "goals" and percentage of "skill topics" treated. He found a highly significant difference among teachers with regard to the level of abstraction. In the dimension of style, a fairly common pattern was revealed with a great emphasis on topics in the areas of "Description" and "Explanation." Few topics dealing with evaluation or decision-making of any sort were found (Gallagher, 1967, pp. 11–14). The significance of the above findings in relation
to the present study is considered in more detail in Chapter V.

A wide diversity of topics was considered by the teachers in this study, though the content under consideration was chapter nine of *Molecules to Man* in all cases. Gallagher concluded that each teacher will plan the strategy of presentation and the emphasis on the basis of his own knowledge, interests, and perceptions of student need regardless of how the materials are organized and presented in a formal sense (1967, p. 14).

Gallagher studied also percentage of teacher and pupil talk, student performance, and student expressiveness. He reported that teachers talked about three to four times as much as students. He found a significant difference among teachers in amount of teacher talk per class, but concluded that teachers generally kept the same proportion of teacher-student talk regardless of the type of topic discussed (Gallagher, 1967, pp. 14-17).

**Summary**

Representative teacher behavior and classroom interaction studies and science teacher behavior and classroom interaction studies have been reviewed in this chapter. Consideration of representative studies has been restricted to those based on some form of direct observation. The review of studies of science
teachers or classes includes also studies in which indirect techniques were used in obtaining information about teacher behavior.

It is apparent that the theoretical frameworks, emphases, and techniques that have been used have differed widely. An inescapable observation is that non-verbal behavior has, in most cases, received very limited attention. The need for objective, inductive, multi-dimensional studies of science teacher behavior is evident.
CHAPTER III

THE METHOD

This chapter is comprised of five major sections as follows:

1. Selection of school systems and teachers cooperating in the study.
2. The use of video tape recording equipment in the schools.
3. Instrument development.
4. Observer agreement.
5. Data collection, encoding, and analysis.

As indicated in the preface, this study and that of Thomas P. Evans were parallel in method with the exception of some aspects of analysis and interpretation of data. Various aspects of methodology, therefore, have been jointly worked out by the researchers. In addition, an independent study was initiated at the same time by Jack G. Matthews utilizing physics teachers in the Cincinnati, Ohio, area. Therefore, various details pertaining to cooperating school systems and the use of video tape recording equipment in the schools were worked out jointly among all three researchers. Details given
in the remainder of this chapter will be restricted to teachers and school systems involved in the parallel studies utilizing biology teachers.

Selection of School Systems and Teachers

Cooperating in the Study

The professional relationship between Dr. John S. Richardson and various administrators in the greater Cincinnati area and the recognized interest in science education research of some of the administrators and science supervisors of the greater Cincinnati schools were important factors in the selection of cooperating schools for this study. The initial contact was made through Dr. John S. Richardson in the spring of 1967. At that time, administrative approval was given for classroom research in the Cincinnati Public Schools and a general oral presentation of research objectives and plans was given to the science supervision personnel of the office of Kenneth E. Vordenberg, Secondary Science Administrative Supervisor, Cincinnati Public Schools. A written introduction relating specific research objectives to the current status of research in science education was presented by Dr. John S. Richardson at this time (Appendix A).

At the second conference with the science supervision personnel of the Cincinnati Public Schools, Mr. Vordenberg presented a
list of biology teachers potentially available to the researchers. The science supervisors, researchers, and Dr. John S. Richardson then visited each of the science teachers under consideration as well as the principal of each school involved. The nature of the research proposed was explained and opportunity was given for questions and discussion. Teachers were assured that the tapes would be regarded as confidential (to be studied only by the researchers and their advisers) and that any additional use of the tapes would be permitted only with the approval of the teacher involved. Teachers were advised that one or two recording sessions were anticipated during the spring of 1967 for instrument development purposes and that a more limited number of teachers would be needed for data collection in the autumn of 1967. Teachers were advised of their freedom to withdraw after participation in the spring recording sessions if they chose. In all, eight biology teachers were contacted in the Cincinnati Public Schools. All biology teachers contacted indicated a willingness to cooperate in the study during the spring recording sessions.

At the same conference, Mr. Vordenberg volunteered also to contact administrators of various surrounding school systems concerning the availability of teachers for the proposed research.
Following contacts by Mr. Vordenberg, the superintendents, principals, and teachers of various surrounding school systems were contacted by the researchers much in the manner described above. The school systems represented in these contacts were Indian Hills, Madeira, Mariemont, and Wyoming. Administrators in three of these four systems indicated an interest in participating in the spring recording sessions and the three biology teachers contacted in the three systems indicated a willingness to cooperate. Administrators and teachers of the fourth school system indicated an interest in participating in the fall but preferred not to participate in the spring.

**The Use of Video Tape Recording Equipment in the Schools**

**Considerations regarding potential**

The use of video tape recording equipment in the schools is of interest from a number of standpoints. From the standpoint of educational research, benefits which accrue from the ability to record for repeated observation and study such details as given sequences of teacher behavior are obvious. In the specific instance of instrument development, the technique proved highly valuable in enabling the researchers to view the same behaviors at different times according to individual preference and convenience, to study
tapes together, discuss them, and repeat observations as necessary in establishing categories and subcategories as mutually exclusive. Furthermore, these records of behaviors became highly valuable as efforts pertaining to observer agreement were undertaken. Again, the method of encoding data developed in this research was made possible because of the use of video tape recording equipment. It is unlikely that an accurate continuous account of teacher behavior could be developed without the option of replay of given sequences of behavior.

Even so, it is likely that these studies represent only a beginning of adequate exploitation of this technique in research. Among further uses already evident are repeated analyses of a given tape by a skilled observer using different portions of a relatively complex instrument and the possibility of repeated analyses of a given tape using completely different procedures and providing completely different kinds of information.

School systems should be aware also of some of the possibilities now open to them for improving in-service education and the self-supervision of teachers. For example, the filming of given lessons presented in contrasting socioeconomic situations offers an interesting possibility for in-service education of first-year teachers. Also, the potential of the availability of such equipment to teachers
for repeated self-analysis in various respects or over a period of time should not be ignored. Implications for those concerned with pre-service education of teachers and student teaching in its various forms are similarly clear.

**Procedures, problems, and suggestions**

The equipment utilized in this research was portable video tape recording equipment. The package was comprised of a camera with tripod equipment, a tape recorder, a microphone, and a video-audio monitoring unit (essentially a modified television set). Carrying cases for the equipment were part of the package.

Special lighting in the classroom was not found to be necessary for research purposes though lighting within the room should be made as uniform as possible. Generally, it was necessary to do the filming in a direction away from direct sources of light such as windows without shades. Apparently some types of cameras are at least temporarily damaged by excessive exposure to bright light. Furthermore, sharply contrasting light intensities required extensive and continuous lens adjustments if the subject being followed in the classroom moved around considerably.
In this research, satisfactory sound reproduction required considerable trial and error. The microphone which accompanied the package worked satisfactorily when used as intended by a given speaker. However, since it was connected to the recorder, it was not feasible for the teacher to carry the microphone with him. Suspending the microphone from the ceiling near the front center of the classroom was satisfactory in a lecture or a teacher-centered discussion, but incorporated the disadvantage of diminishing pick-up when the teacher moved to certain areas of the classroom. In addition, with considerable classroom activity, the relative lack of selectivity in sound pick-up became a problem in that teacher verbal behavior often could scarcely be distinguished from background noise. Most of the above-mentioned problems were substantially relieved in this study by use of a small pocket-sized wireless microphone which was worn in a lab coat or a suit coat. This necessitated use of a tuner, of course, but this combination was found to work quite satisfactorily. A high quality FM tuner with frequency lock-in was found to be desirable. Even here, it should be noted that some schools and some classrooms within schools were more susceptible to interference than others. In three classrooms, the researchers placed an antenna of double lead television antenna wire around the
room, thus almost eliminating the FM interference problem. Finally, a refinement was added which made it possible to pick up a fair amount of classroom interaction while retaining audio predominance of the teacher. This was done by placing a microphone within a parabola and mounting the apparatus on a tripod. By monitoring the audio portion through the recorder with a set of earphones, it was possible to regulate the volume of audio pick-up satisfactorily resulting in considerable improvement in reproduction of the audio portion of classroom behavior.

Attempts to utilize the video tape recording equipment within the Science Education Center at The Ohio State University preliminary to actual classroom observation by the researchers had revealed one other important problem that should be mentioned. Although the equipment seemed to function as intended, the image of the teacher on the screen at classroom distance was much too small to permit identification of non-verbal behaviors with the degree of specificity required in this research. The use of appropriate zoom lenses was found to fill this need quite satisfactorily.

In addition, it was learned that access to competent service personnel was an absolute requisite. Optimum functioning of the camera required quite fine tuning by trained electronics experts. On
a few occasions repairs and maintenance were required which also demanded the services of trained electronics experts.

Assembly and removal of equipment from classrooms and transportation of equipment presented a minimum of difficulties if properly planned. Equipment was brought into a classroom, assembled, and checked out by two men in five to ten minutes once the various early difficulties were worked out and a routine was established. By moving into a school or classroom several minutes before change of classes, assembly was accomplished by the time the new class period was underway.

The equipment used was not inconspicuous, but no more than one back corner of a room, one small laboratory table, and two electrical outlets were required for placement and operation of the equipment. The researchers attempted to minimize direct effects of the presence of the equipment and operators on teacher behavior by emphasizing in preliminary discussions with the teachers that specially prepared lessons for taping sessions were not desirable since biasing of the research would result. Furthermore, specific dates and class periods were not established in advance during data collection in a further effort to minimize this possible bias. Student curiosity was evident during the early minutes of a given
recording session but with few minor exceptions, student classroom activity was not obviously affected thereafter.

**Instrument Development**

The selection of schools and teachers cooperating in this study has been discussed in an earlier section of this chapter. Video tape recordings of eleven teachers were made for use in instrument development. In the process of improvement of the quality of the video tapes, behaviors of one teacher were taped on three occasions, though most teachers were video taped only once. For these pilot recording sessions in the spring, specific arrangements were made with the teachers for a suitable day for video tape recording. In this manner, the researchers obtained thirteen video tapes of biology teacher behaviors which were used in the process of instrument development. The length of the teacher behavior records on the tapes ranged from thirty-five minutes to sixty minutes. Classes in which teacher behaviors were recorded included BSCS "Blue Version," BSCS "Green Version," BSCS "Yellow Version," BSCS "Special Materials," "Basic Biology," "General Biology," "Academic Biology," Physiology, and Zoology. Eight of the teachers involved were men and three were women. Tapes were taken at any hour of the school day subject only to limitations of the schedules,
location of the schools, and transportation. The teachers were permitted to view as much of the video tape as they desired at the completion of the taping session.

Each of the tapes was returned to The Ohio State University where it was played back using the video tape equipment. Independently, each researcher studied each of the tape recordings one or more times. Each researcher then recorded in the form of short notes the various specific verbal and non-verbal behaviors of the teachers as observed from the video tapes. The examples below taken from original transcriptions are illustrative of the form the records of teacher behaviors took at this stage of instrument development:

- Takes roll.
- Smiles while listening to student's comments.
- Asks, "What usually happens?" in response to student question.
- Asks terminology question.
- Illustrates content with hand motions.

Next, each researcher transcribed these behaviors as he had recorded them to individual index cards. These cards were then categorized independently by the researchers with groups or stacks of cards resulting. Both in the recording of behaviors and in grouping
the behaviors as stacks of cards, behavioral intent of the teacher and behavioral effect on students were inferred.

At this stage, the researcher ascribed descriptive terms or phrases to his numerous groups of cards. It was found useful to make quite numerous groups of cards on the basis of specific behavior similarities. As descriptive terms and phrases were applied to these groups of cards, it was possible to combine some of these specific groups into broader categories of teacher behavior.

The researchers began working jointly at this point by bringing these records of teacher behaviors which were still in relatively specific groups together. Further combinations of these groups of behaviors and between the records of the two researchers were made. On the basis of these developing understandings of teacher behaviors, tentative category and subcategory titles and definitions were developed. Repetitious records of the same behavior in given categories and subcategories were eliminated and glossaries of teacher behaviors were prepared in association with the various categories and subcategories. The basic structure of the observational system was thus inductively developed.

With these tentative records complete, the entire instrument was again studied critically by both researchers. This effort revealed
certain duplications of items in glossaries, certain areas in which overlap among categories or subcategories seemed logically possible, and several aspects in which the researchers needed to achieve greater clarity and agreement in categorization. Additional refinement of the inductive observational system took place in association with observers practicing using the instrument in preparation for observer agreement attempts. The inductive observational system was entitled the Biology Teacher Behavior Inventory. A brief description of the Biology Teacher Behavior Inventory is presented in Chapter IV. Appendixes E to G constitute the entire inductive observational system.

Development of Processes for Encoding Behaviors

After the above refinements were made, the researchers turned their attention to the problem of encoding the data. Since the Biology Teacher Behavior Inventory was developed on the basis of specific behaviors of the teachers and the video tape record of teachers was available for a stop-and-go replay of these behaviors, the researchers chose to make a continuous account of teacher behaviors. In addition, the researchers desired to record behaviors as verbal, non-verbal, congruent, or contradictory. This was
accomplished by use of the Data Record (Appendix C) which enabled an observer to directly record a behavior in the appropriate column. Verbal behaviors and non-verbal behaviors were encoded on the basis of the definitions given in Chapter I. Behaviors were encoded as congruent when verbal and non-verbal behaviors occurred simultaneously and complemented each other. If they seemed unrelated to each other, the coder decided which was the principal behavior in terms of behavioral intent and effect. If simultaneous behaviors contradicted each other, they were encoded as contradictory.

For the purposes of this study, it was considered desirable to condense somewhat the massive data resulting from a continuous account of teacher behaviors. It was hoped that this could be accomplished without equating all behaviors regardless of duration in time, as would be the case if each occurrence of a behavior were simply recorded as a frequency of one. The researchers, therefore, attempted to apply timed intervals to the continuous account of teacher behaviors. This was accomplished by first making the continuous account of teacher behaviors and then playing back the video tape and a simultaneous audio record with "beeps" denoting the desired timed intervals. By watching the record of behaviors, it was thus possible to mark off timed intervals on the Data Record.
Within each timed interval, the predominant behavior (on the basis of time consumed) was then recorded. This procedure provided the advantage of enabling the researcher to make decisions inductively on the basis of a descriptive account instead of relying on his subjective impressions regarding the predominant behavior in a given timed interval.

Trial efforts were made using five-second, ten-second, and fifteen-second intervals. With fifteen-second intervals, many behaviors were lost; with five-second intervals, many behaviors were not completed. On these bases, it was decided that the ten-second interval was the most appropriate.

Occasionally, two behaviors occupied equal time in a given timed interval. On these occasions, the interval before and the interval after the one under consideration were examined and the predominant behavior was recorded on the basis of the most accurate representation of the behaviors in these intervals.

**Observer Agreement**

A measure of observer agreement was obtained by use of the Scott Index of Inter-coder Agreement (1955). The use of this technique has been suggested for studies in which the coding dimensions are composed of nominal scales, as is the case with the
instrument here under consideration. In addition, the Scott Index of Inter-coder Agreement was considered to have the benefits of correcting for the number of categories in the instrument and the frequency of usage of each category (1955, pp. 321-323).

The Scott coefficient ($\pi$) was determined as follows:

$$\pi = \frac{P_0 - P_e}{1 - P_e}$$

$P_0$ is the percentage of judgments on which the two observers agree and was obtained by subtracting the percentage of disagreements from 100 per cent. $P_e$ is the per cent agreement to be expected on the basis of chance and was obtained by squaring the per cent agreement between the observers for each category and then summing these squared proportions over all the categories.

$$P_e = \sum_{i=1}^{k} p_i^2$$

The number of categories in the instrument is represented by $k$, and $p_i$ is the proportion of all behaviors in the sample which fall into the $i$ category.

The initial measure of observer agreement was obtained prior to actual encoding of data by use of the inductive observational system on the video tapes taken during the spring of 1967. The
measure was taken by use of the Scott Index of Inter-coder Agreement on fifteen five-minute sections of the video tapes.

By using the counter on the tape recorder, it was possible to designate numerically five-minute intervals on each of the tapes available. These intervals were assigned tape and interval numbers and the identification slips were drawn at random as a sample of biology teacher behavior. The fifteen five-minute sections of tape thus selected were preserved for collection of data regarding observer agreement.

Since video taping was proceeding in the Cincinnati area simultaneously, it was desirable to conserve video tapes. This was accomplished by re-recording the fifteen intervals on three thirty-minute tapes. In this manner all the video tapes taken during the spring of 1967 were released for use during the fall while the observer agreement work progressed.

It is important to note that it was necessary that observers agree not only with respect to the subcategory recorded for a given behavior, but also with respect to the form of expression. That is, it was necessary that they agree whether the behavior was verbal, congruent, non-verbal, or contradictory. Using the Data Record (Appendix C), each observer independently recorded a continuous
second by second account of teacher behavior for a given five-minute interval. This record was then divided into ten-second intervals and the predominant behavior (on the basis of time consumed) for each ten-second interval was recorded. When calculations of observer agreement were made, each form of expression for each behavior was treated separately, thus insuring that agreement with respect to form of expression was incorporated into observer agreement calculations.

Once observer agreement had been established, actual encoding of data from video tapes being taken during the fall of 1967, was undertaken. At approximately midpoint in data encoding and again near the end, observer agreement was checked. For these checks, two tapes were drawn at random from tapes that had not yet been encoded. From each tape, two five-minute intervals of teacher behavior were drawn at random. The ten minutes of teacher behavior thus obtained from one tape were encoded by each observer near midpoint in encoding of data and the ten minutes from the other tape were encoded by each observer near the end of encoding of data. The results of all the observer agreement measures are presented in Chapter IV.
Data Collection, Encoding, and Analysis

Sample selection and description

In early September of 1967, the researchers called at the science supervision office of Kenneth Vordenberg to discuss locations and assignments of the biology teachers needed for data collection. On the basis of teaching assignment, location, and teacher or school request, six of the Cincinnati Public School biology teachers who had participated in the spring recording sessions were selected. In addition, the two biology teachers at Indian Hills High School were chosen.

The teachers were individually contacted and invited to participate in the study. They were advised that they were not obligated to participate because of involvement in the recording sessions of the spring of 1967. All eight of the teachers contacted agreed to continue participation in the study. Each of the teachers who was not requested to continue participation in the study was contacted in person or by telephone. In each case, the researchers explained criteria for selection of teachers being video taped during the fall.

The classes scheduled to be video taped included one class each of BSCS "Green Version" biology, BSCS "Blue Version" biology, BSCS "Yellow Version" biology, and BSCS "Special Materials" biology.
Three of the other four teachers taught conventional biology and the other one taught zoology. Five of the teachers were men and three were women.

Video tape recording in the science classroom

The researchers requested permission of the teachers to arrive unannounced for recording sessions since it was felt that advance notice of planned recording sessions might result in modified planning and, therefore, increased bias in the behaviors recorded. Each of the teachers agreed to this arrangement. It was agreed that if a major portion of the class period happened to be devoted to activities in which meaningful teacher behaviors were not readily recorded (such as showing films and giving examinations) the researchers would move on to another teacher and return at a later time. It was possible to carry out this plan in practice with only two exceptions. These pertained to one teacher who received a student teacher who was scheduled to teach every day after the teacher had been video taped only three times. Upon being contacted by the researchers, the teacher made arrangements to teach two days, and he was video taped those two days.

The forty video tapes were taken during September, October, and November of 1967. The tapes taken ranged from approximately
forty minutes to fifty-eight minutes in length. The forty-minute minimum length was set since some ninth grade biology classes were only forty-five minutes in length.

**Encoding of data**

Data encoding was accomplished by means of the processes already described. Some of the encoding was accomplished before all forty video tape recordings had been taken so that some of the tapes could be used a second time.

Since a continuous account of teacher behavior was desired, the process of encoding was found to be quite time consuming. Often (and especially on the first several tapes encoded) the researcher found it necessary to replay sequences of behaviors to insure accuracy of the encoding process. As might be anticipated, the ease of encoding varied greatly with the complexity of the behaviors involved. Most of the time it was necessary to replay the entire tape so that the timed interval could be imposed on the continuous account of teacher behaviors. In all, approximately four hours of work were required for the researcher to accurately encode continuous behaviors and identify predominant behaviors on the basis of ten-second intervals from a fifty-minute biology class.
Processing and analyses of data

When encoding of data as described above had been completed, the predominant behaviors over ten-second intervals had been entered on the Data Record. To obtain the frequencies of the various behaviors, each behavior was totaled separately with respect to behavior and form of expression and the total was entered in the appropriate space of the Master Data Record (Appendix D). This was done separately for each of the forty tapes. Following this, the totals from each Master Data Record of a given teacher were combined on a single Master Data Record for that teacher. Thus there was a Master Data Record for each class period that a teacher was video taped and a Master Data Record showing the total frequencies of each dominant behavior within each form of expression for a teacher on all five sessions.

In order to obtain data concerning the BSCS teachers and the non-BSCS teachers, the final Master Data Records of the four BSCS teachers were brought together and the final Master Data Records of the four non-BSCS teachers were brought together. By totaling, for each item, the frequencies of the two groups of Master Data Records separately, a single Master Data Record was produced for the BSCS teachers and one for the non-BSCS teachers.
As implied above, the total lengths of the video taping sessions were not perfectly equivalent. It was, therefore, essential that the frequencies of various behaviors for individual teachers, BSCS teachers as a group, and non-BSCS teachers as a group, be converted to percentages of the total number of behaviors in each situation.

Decisions regarding statistical analyses were made on the bases of the research design, the specific problem statement, and consultation with Dr. John S. Richardson, Dr. D. Ransom Whitney, and Dr. Wallace Fotheringham.

From the outset, it was judged that the statistics used in this study should be non-parametric since a limited number of teachers would be administratively identified for the study. Also, only schools and teachers indicating a willingness to cooperate in the study were video taped, a factor which may have influenced the sample actually utilized. In other words, it would be difficult to defend the proposition that the teachers involved in this study represented a random sample from a normal population.

In this study, the criterion for testing of the hypotheses concerning similarities and differences among the teachers and between BSCS teachers and non-BSCS teachers was the .05 level of confidence
on the statistical tests employed. For a measure of the intercorrelation among ranking of all eight teachers on the categories, subcategories, and subdivisions, the Kendall Coefficient of Concordance was used. A measure of significant differences among the teachers with respect to various items of the Biology Teacher Behavior Inventory was obtained by means of the Kruskal-Wallis one-way analysis of variance by ranks. The probability of differences between the BSCS teachers and the non-BSCS teachers with respect to the categories, subcategories, and subdivisions of the instrument was measured by means of the Mann-Whitney U Test.
CHAPTER IV

THE RESULTS

Statement of the Problem and Method

The purpose of this study was to achieve the following objectives:

1. To develop an instrument for the categorization of biology teacher behaviors.

2. To record behaviors and patterns of biology teacher behavior by means of utilization of the instrument on video tape recordings taken in the classroom.

3. To identify aspects of teacher behavior patterns that differ significantly among teachers and aspects that appear relatively similar or correlate highly among teachers.

4. To identify behaviors and/or patterns of teacher verbal and non-verbal behavior that differ significantly between BSCS teachers and non-BSCS teachers.

An outline of the method and procedures used to achieve the objectives has been presented in Chapter I. A detailed description
of the method and procedures constitutes Chapter III. The two central components of the method were: (1) Instrument development, (2) Data collection and analysis. Initially, thirteen video tapes were taken from which the instrument (Biology Teacher Behavior Inventory) and encoding processes were inductively developed. After this was done and initial observer agreement work had been completed, forty video tape recordings of biology teachers were made and the data were encoded and analyzed.

In the remainder of this chapter, the results are presented in three major sections: (1) The First and Second Hypotheses (which pertain to the instrument), (2) The Third and Fourth Hypotheses (which are concerned with similarities and differences among the various teachers studied), (3) The Fifth and Sixth Hypotheses (which pertain to similarities and differences between the BSCS teachers and non-BSCS teachers studied).

The First and Second Hypotheses

The first hypothesis stated that an instrument incorporating both verbal and non-verbal behaviors of biology teachers could be developed. The second hypothesis stated that an instrument meeting the above requirements could be constructed on a category basis to
incorporate behaviors pertinent to studies of teacher behavior with widely differing objectives.

The results which pertain to the first and second hypotheses are presented in five sections: (1) Description of the Instrument, (2) Description of Encoding Processes, (3) Observer Agreement, (4) The Use of the Instrument, (5) Discussion and Summary.

Description of the Instrument

The complete Biology Teacher Behavior Inventory consists of three parts. The three parts are presented in complete form in Appendixes E through G. Part I is comprised of a listing in outline form of the various categories and subcategories of the observational system. Part II consists of the definitions of the categories, subcategories, and subdivisions. In Part III, the glossaries of behaviors are presented for each category, subcategory, and subdivision.

The structure of the Biology Teacher Behavior Inventory is based on seven categories of teacher behavior, some of which also have subcategories. The first category is that of "Management" and includes the following three subcategories: (1) Routine Management, (2) Laboratory Management, (3) Study Management. The second category is that of "Control," and the third is "Release." Category four is "Goal Setting." Categories two, three, and four have no
subcategories. The fifth category is "Content Development" and it is the most complex of the categories. Category six is "Affectivity" and it is composed of two subcategories as follows: (1) Positive Affectivity, (2) Negative Affectivity. The seventh Category is "Undecided" and was used when behaviors could not be classified into one of the other six categories.

In the first category (Management), all behaviors comprising "housekeeping" activities, assignments, and affecting of directed study are included. The subcategory "Routine Management" is comprised of behaviors which could be expected to occur in non-science classrooms as well as in biology. Control of physical environment and handling of administrative details are illustrative of this subcategory. The subcategory "Laboratory Management" is made up of behaviors comprising the management of the biological science laboratory. Both maintenance and supervision of student laboratory work are included. The subcategory "Study Management" is constituted of behaviors which specify assignments or provide for directed study, these being aspects of management in the learning situation.

The category "Control" is the second category and is comprised of behaviors which structure or regulate student behavior. These behaviors may be verbally explicit, non-verbal expressions,
or the use of silence. Such behaviors are not necessarily in the form of reprimands and are not primarily of a negative affectivity orientation. Involved, among others, are behaviors specifying deadlines or time limitations on work to be done by students.

"Release" is the category into which teacher behaviors are placed which give increased responsibility for student behaviors to the students themselves; the teacher releases control or reduces social distance between himself and the students.

The fourth category is "Goal Setting." Behaviors of the teacher which explicitly or implicitly focus on the purposes of a given activity comprise this category. These may take the form of justifications for an area of study, stating or reading the objectives of an exercise, or emphasizing the importance of certain knowledge.

"Content Development" is the fifth category. Behaviors which deal primarily with the subject matter in relation to achievement of content objectives comprise this category. Several sets of alternatives were devised, making it possible to obtain extensive information with a minimum increase in the difficulty of usage of the instrument. Behaviors within "Content Development" may be either "Teacher Centered" (5a in symbol form) or "Student Centered" (5b in symbol form). The subdivisions under both of the above subcategories
are as follows: (1) Procedures, (2) Knowledge, (3) Scientific Process, (4) Tentativeness of Knowledge, (5) Generalizations, (6) Articulation of Content, (7) Facilitates Communication. Within the subdivisions are acts of communication and these are identical within each of the seven subdivisions. The acts of communication are: (1) States, (2) Asks, (3) Shows, (4) Acknowledges, (5) Clarifies. The alternatives are thus two, seven, and five in number within "Content Development."

When content is being developed, teacher behaviors are "Teacher Centered" when the attention of most students is on the teacher, the teacher is attempting to obtain the attention of most students, or the teacher asserts himself in relation to an individual student or a group of students. When content is being developed but teacher behaviors cannot be characterized as above, the behaviors are "Student Centered."

The first of the subdivisions of "Content Development" is "Procedures" (5a1 or 5b1 in symbol form). It is comprised of behaviors dealing with instruction in procedures. In other words, the behavioral intent or effect here is that students are able to perform certain operations which are part of the subject matter of the biology classroom.

The second subdivision is "Knowledge." The behaviors comprising this subcategory pertain to giving and receiving information
at relatively low cognitive levels. The usual mental process expected is recall and some common aspects of content involved are facts, definitions, and terminology.

"Scientific Process" is the third of the subdivisions. The higher intellectual processes of observation, interpretation, extrapolation, application, analysis, synthesis, and evaluation are included in the content considerations of these teachers' behaviors.

The fourth subdivision is "Tentativeness of Knowledge" and the teacher behaviors which comprise it center around the statement or implication of a state of change or incompleteness of scientific knowledge.

"Generalizations" is the fifth subdivision of "Content Development." The behaviors which comprise this subdivision develop content in considerable breadth when contrasted with other content considerations being undertaken by the teacher. The teacher may explicitly state that he is making generalizations or summarizations or the change from depth to breadth emphasis may be identified by the observer on the basis of his knowledge of teacher behavior and the content of biology.

"Articulation of Content" is the sixth subdivision of "Content Development." The behaviors included are those which integrate content across topics or time.
The last of the subdivisions of behaviors in which the teacher develops content is "Facilitates Communication." While the context of these teacher behaviors is content development, the specific focus is that of communication as contrasted with facilitating knowledge or comprehension. Repeating a statement for those who did not hear or motions and movements which draw attention to certain content are illustrative of verbal and non-verbal forms these behaviors may take.

The sixth category is called "Affectivity." Behaviors which constitute this category are those which, in some form, encourage or discourage student contributions to the teaching-learning process. Behaviors which elicit and reinforce such contributions positively constitute the subcategory "Positive Affectivity" (6a in symbol form), while those which do so negatively constitute the subcategory "Negative Affectivity" (6b in symbol form). Smiles and reassurances are behaviors which illustrate positive affectivity; ignoring student contributions or using harshness in correcting students are behaviors which illustrate negative affectivity.

The seventh category is termed "Undecided." It simply provides a means of insuring that a continuous record of teacher behaviors can be produced, should some behaviors not be categorizable elsewhere in the instrument.
Description of encoding processes

A detailed account of the techniques involved in the development of encoding processes was presented in Chapter III. The product of these efforts was a system of encoding which took advantage of the specificity and accuracy of encoding made possible by the Biology Teacher Behavior Inventory and the video tape recording equipment.

Encoding of data was accomplished by writing a continuous second-by-second account of teacher behaviors in symbol and "dot" form. Use of the Data Record (Appendix C) enabled the observer to encode behaviors as verbal, congruent, non-verbal, or contradictory by entering teacher behaviors in the appropriate column. A given behavior was written down in symbol form (5a2a for teacher centered knowledge statement, for example) and as long as the same behavior continued to be expressed in the same manner, dots were recorded at the rate of approximately one every second downward in the same column. If the behavior remained the same but the form of expression changed (from verbal to congruent, for example), the encoder simply switched to the appropriate column and continued recording dots.

The second step in the encoding process developed in this study was the reduction of the data to a form that was statistically manageable. This was accomplished by applying ten-second intervals to the continuous account of teacher behaviors on the Data Records.
The predominant behavior in each interval on the basis of time consumed was then entered in the appropriate column of the Data Record. In this study, frequencies of behaviors were tabulated on the basis of predominant behaviors, and the frequencies were converted to percentages since total numbers of behaviors recorded were not identical for all teachers.

Observer agreement

Procedures used in checking observer agreement and making calculations are presented in detail in Chapter III. Fifteen five-minute random samples of teacher behavior were used in the initial observer agreement attempts. This work took place before actual encoding of data. Table 1 shows the results of these fifteen attempts, the figures representing the degree of observer agreement as measured by the Scott Coefficient of Inter-coder Agreement. Total observer agreement as calculated on the basis of all fifteen samples was 0.92.

Observer agreement was checked on two additional occasions using ten-minute samples each time which had been randomly selected. One of the checks was made at approximately mid-point of encoding data; the other was made near the end of data encoding. The results were observer agreement figures of 0.95 and 0.93, respectively.
TABLE 1

OBSERVER AGREEMENT BASED ON THE SCOTT COEFFICIENT
OF INTER-CODER AGREEMENT

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Use of the instrument

In this study, the Biology Teacher Behavior Inventory was used to encode biology teacher behaviors from forty class periods. These data were examined for information concerning similarities and differences in behavior among teachers and between BSCS teachers and non-BSCS teachers.

The study of Thomas P. Evans was parallel in part to this study, but in his study the data were examined for correlations with various scores obtained by the teachers on the Guilford-Zimmerman Temperament Survey.

Each researcher found that the Biology Teacher Behavior Inventory in its present form and the processes for encoding behaviors were appropriate for meeting the needs of his research design. That is, neither researcher found it necessary to search for or eliminate
certain behaviors or to modify the instrument in order to obtain data in a usable form, even though the specific objectives of data analysis differed greatly.

Discussion and summary

The first hypothesis stated that an instrument incorporating both verbal and non-verbal behaviors of biology teachers could be developed. The results presented have clearly revealed that such an instrument can be developed. In this study, descriptions of behaviors were developed without restriction to verbal and non-verbal components. Rather, the forms of expression (verbal, congruent, non-verbal, and contradictory) were incorporated in the data by encoding the behavior descriptions in the appropriate columns of the Data Record. The form of expression thus did not become the sole basis for description of behaviors, but the result of these descriptions. That is, the Biology Teacher Behavior Inventory incorporates verbal and non-verbal behaviors without being organized exclusively according to forms of expression.

An additional source of evidence that the first hypothesis can be accepted was that the seventh category (Undecided) was used very seldom. Only 0.09 per cent of all behaviors encoded were placed in the "Undecided" category and most of these were because of malfunction of electronic equipment. Hence, the Biology Teacher
Behavior Inventory not only incorporates forms of expression, but appears also to have had a broad enough inductive base to incorporate essentially all of the biology teacher behaviors encountered in this study.

A third source of evidence leading to acceptance of the first hypothesis was that observer agreement figures were highly acceptable (Table 1). Evidence was thus provided that two observers encoded a given behavior in its context identically in symbol and form of expression with relatively rare exception. The first hypothesis was, therefore, accepted.

The second hypothesis stated that an instrument meeting the above requirements could be constructed on a category basis to incorporate behaviors pertinent to studies of teacher behavior with widely differing objectives. The Biology Teacher Behavior Inventory has been constructed on a category basis and has been used in two studies with quite different objectives.

In this study, the term "category" was defined as a major division or section of the instrument into which certain behaviors were classified and from which all other behaviors were excluded. To a considerable degree, development of the instrument on a category basis was assured through the method of instrument development. The
behaviors were organized into many small groups by describing each behavior in context and inferring its behavioral intent or effect, writing it on a separate card, and then combining the cards on the basis of similarities in description and inferred intent or effect. These small groups were successively combined to form larger groups eventually comprising subcategories and categories. In this manner, each behavior in its context was eventually placed in one and only one subcategory and category. The definitions of categories, subcategories, and subdivisions (Appendix F) represent the criteria established during instrument development for decision-making in the categorization of teacher behaviors.

Considerable additional evidence that the above efforts to establish mutually exclusive categories, subcategories, and subdivisions were successful was provided by the combination of high observer agreement (Table 1) and the low usage of the "Undecided" category (Table 2). It was thus shown that observers very seldom felt the need to go to the "Undecided" category and that they agreed a very high proportion of the time on categorization of behaviors utilizing almost entirely the six major categories of the instrument.

It has been shown under "The Use of the Instrument" above that the behaviors incorporated and also the organizational structure of the Biology Teacher Behavior Inventory were appropriate for use in
two studies in which objectives differed greatly. Although it is likely that for some objectives of teacher behavior study it would be desirable to modify certain components of the instrument and/or the encoding processes (such as increasing or decreasing sensitivity in certain areas), it was clear on the basis of the studies of Evans and of Balzer that the instrument incorporated behaviors pertinent to some studies with widely differing objectives. With respect to these studies, the second hypothesis was, therefore, accepted.

The Third and Fourth Hypotheses

The third hypothesis stated that some aspects of biology teacher verbal and non-verbal behavior could be identified which correlate highly for the biology teachers involved in the study. The fourth hypothesis stated that some aspects of biology teacher verbal and non-verbal behavior would be seen to vary substantially, and would be significantly different.

The results which pertain to the third and fourth hypotheses are presented in three sections: (1) Similarities in Behaviors of Teachers, (2) Differences in Behaviors of Teachers, (3) Discussion and Summary.
Similarities in behaviors of teachers

The percentage of the total behaviors of each teacher is presented for each category of the Biology Teacher Behavior Inventory in Table 2.

<table>
<thead>
<tr>
<th>Categories</th>
<th>Teachers 1</th>
<th>Teachers 2</th>
<th>Teachers 3</th>
<th>Teachers 4</th>
<th>Teachers 5</th>
<th>Teachers 6</th>
<th>Teachers 7</th>
<th>Teachers 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>45.14</td>
<td>4.35</td>
<td>0.66</td>
<td>0.46</td>
<td>47.89</td>
<td>1.40</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>52.82</td>
<td>1.54</td>
<td>1.81</td>
<td>0.53</td>
<td>41.85</td>
<td>1.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>32.29</td>
<td>0.62</td>
<td>1.73</td>
<td>1.52</td>
<td>63.54</td>
<td>0.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>51.52</td>
<td>0.86</td>
<td>1.06</td>
<td>0.33</td>
<td>44.34</td>
<td>1.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>57.00</td>
<td>3.29</td>
<td>0.71</td>
<td>0.51</td>
<td>38.15</td>
<td>0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>12.99</td>
<td>2.16</td>
<td>4.06</td>
<td>1.83</td>
<td>75.13</td>
<td>3.74</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>63.31</td>
<td>2.04</td>
<td>1.16</td>
<td>0.54</td>
<td>31.62</td>
<td>0.68</td>
<td>0.61</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>39.67</td>
<td>0.75</td>
<td>1.44</td>
<td>0.75</td>
<td>55.99</td>
<td>1.31</td>
<td>0.06</td>
<td></td>
</tr>
</tbody>
</table>

For all teachers studied, the greatest percentages of time by far were given to behaviors in the first category (Management) and the fifth category (Content Development). In each case, a much smaller percentage of time was devoted to behaviors in each of the categories of "Control," "Release," "Goal Setting," "Affectivity," and "Undecided." Though the magnitudes of the percentages within each category varied considerably, the relationship of the first and fifth categories to the other five categories was true of all eight
teachers studied; their behaviors were similar in that respect. Their behaviors were similar also in that although the percentages of time spent in behaviors of the categories "Control," "Release," "Goal Setting," and "Affectivity" were quite small, some behaviors in all of these categories were encoded for all teachers.

Table 3 presents the percentage of behaviors by teachers in each subcategory of the Biology Teacher Behavior Inventory. An additional similarity in the behaviors of all eight teachers that was not evident from Table 2 is with respect to teacher-centered and student-centered behaviors of "Content Development" (5a and 5b). In all cases, the percentage of teacher-centered content development behaviors was much greater than the percentage of teacher behaviors that was student-centered.

In Table 4 the percentage of "Content Development" behaviors classified in each of the seven subdivisions of "Content Development" for each of the eight teachers studied is presented. For all eight teachers studied, the percentage of behaviors pertaining to "Tentativeness of Knowledge" (5-4) and "Generalizations" (5-5) was very low in comparison to "Procedures" (5-1), "Knowledge" (5-2), and "Facilitates Communication" (5-7). For six of the teachers, "Articulation of Content" (5-6) was also much lower than "Procedures,"
<table>
<thead>
<tr>
<th>Subcategory or Category</th>
<th>Teachers</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
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<td>1a</td>
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<td>8.80</td>
<td>19.68</td>
<td>6.32</td>
<td>6.23</td>
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<tr>
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<td>9.49</td>
<td>17.42</td>
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<tr>
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<td>4.35</td>
<td>1.54</td>
<td>0.62</td>
<td>0.86</td>
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<td>2.16</td>
</tr>
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<td>0.66</td>
<td>1.81</td>
<td>1.73</td>
<td>1.06</td>
<td>0.71</td>
<td>4.06</td>
</tr>
<tr>
<td>4</td>
<td>0.46</td>
<td>0.53</td>
<td>1.52</td>
<td>0.33</td>
<td>0.51</td>
<td>1.83</td>
</tr>
<tr>
<td>5a</td>
<td>43.13</td>
<td>37.55</td>
<td>61.46</td>
<td>41.88</td>
<td>34.86</td>
<td>74.80</td>
</tr>
<tr>
<td>5b</td>
<td>4.75</td>
<td>4.30</td>
<td>2.07</td>
<td>2.46</td>
<td>3.29</td>
<td>0.32</td>
</tr>
<tr>
<td>6a</td>
<td></td>
<td>0.80</td>
<td>0.27</td>
<td>1.39</td>
<td>0.12</td>
<td>0.72</td>
</tr>
<tr>
<td>6b</td>
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<td>0.60</td>
<td></td>
<td>0.46</td>
<td>0.19</td>
<td>3.01</td>
</tr>
</tbody>
</table>
"Knowledge," and "Facilitates Communication." Five of the eight teachers spent more time at the "Knowledge" level than at the "Scientific Process" level, and five spent more time at the "Procedures" level than at the "Scientific Process" level. Seven of the teachers spent more time at "Facilitates Communication" (5-7) than they did at "Scientific Process," "Tentativeness of Knowledge," "Generalizations," or "Articulation of Content." Six of these seven teachers also spent more time at "Facilitates Communication" than at "Procedures."

TABLE 4

PERCENTAGE OF CONTENT DEVELOPMENT BY TEACHERS IN THE SUBDIVISIONS OF CONTENT DEVELOPMENT

<table>
<thead>
<tr>
<th>Teachers</th>
<th>Subdivisions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5-1</td>
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<tr>
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<td>14.68</td>
</tr>
<tr>
<td>2</td>
<td>11.57</td>
</tr>
<tr>
<td>3</td>
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<td>6</td>
<td>10.65</td>
</tr>
<tr>
<td>7</td>
<td>38.44</td>
</tr>
<tr>
<td>8</td>
<td>11.88</td>
</tr>
</tbody>
</table>

Table 5 shows the percentage of behaviors by teachers in the various forms of expression, based on all behaviors encoded for each teacher. The behaviors of these teachers were similar in that all
showed substantial percentages of behaviors in the "Verbal," "Congruent," and "Non-verbal" forms of expression but a very low percentage of behaviors classified as "Contradictory."

**TABLE 5**

PERCENTAGE OF BEHAVIORS BY TEACHERS IN THE VARIOUS FORMS OF EXPRESSION

<table>
<thead>
<tr>
<th>Forms of Expression</th>
<th>Teachers</th>
<th>Verbal</th>
<th>Congruent</th>
<th>Non-verbal</th>
<th>Contradictory</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
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<td>17.81</td>
<td>33.35</td>
<td>.</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>24.83</td>
<td>41.11</td>
<td>33.91</td>
<td>00.13</td>
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<tr>
<td></td>
<td>3</td>
<td>41.30</td>
<td>34.65</td>
<td>.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>28.19</td>
<td>25.93</td>
<td>45.81</td>
<td>00.06</td>
</tr>
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<td>5</td>
<td>32.21</td>
<td>13.75</td>
<td>53.97</td>
<td>00.06</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>45.34</td>
<td>18.37</td>
<td>35.82</td>
<td>00.45</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>22.33</td>
<td>23.77</td>
<td>53.82</td>
<td>00.06</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>34.90</td>
<td>34.46</td>
<td>30.57</td>
<td>00.06</td>
</tr>
<tr>
<td>1-8</td>
<td>34.76</td>
<td>26.18</td>
<td>38.94</td>
<td>00.10</td>
<td></td>
</tr>
</tbody>
</table>

In Table 6 the percentage of "Content Development" behaviors comprised of the various communication acts by each teacher and by all teachers is presented.

For each teacher, "States" comprised a substantially greater proportion of "Content Development" behaviors than any other of the communication acts studied. In all cases, "Acknowledges" was exceeded only by "States," though the eighth teacher devoted equal percentages of time to "Acknowledges" and "Asks." Five of the
TABLE 6
PERCENTAGE OF CONTENT DEVELOPMENT BY TEACHERS COMPRISED OF THE VARIOUS COMMUNICATION ACTS

<table>
<thead>
<tr>
<th>Teachers</th>
<th>States (a)</th>
<th>Asks (b)</th>
<th>Shows (c)</th>
<th>Acknowledges (d)</th>
<th>Clarifies (e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>69.51</td>
<td>2.23</td>
<td>7.83</td>
<td>18.88</td>
<td>1.53</td>
</tr>
<tr>
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<td>52.73</td>
<td>18.16</td>
<td>5.94</td>
<td>19.13</td>
<td>4.01</td>
</tr>
<tr>
<td>3</td>
<td>80.04</td>
<td>4.14</td>
<td>8.94</td>
<td>4.79</td>
<td>2.07</td>
</tr>
<tr>
<td>4</td>
<td>38.53</td>
<td>15.89</td>
<td>11.69</td>
<td>25.93</td>
<td>7.94</td>
</tr>
<tr>
<td>5</td>
<td>49.23</td>
<td>13.87</td>
<td>3.89</td>
<td>29.44</td>
<td>3.55</td>
</tr>
<tr>
<td>6</td>
<td>53.18</td>
<td>5.41</td>
<td>0.87</td>
<td>33.10</td>
<td>7.42</td>
</tr>
<tr>
<td>7</td>
<td>46.22</td>
<td>11.66</td>
<td>11.23</td>
<td>24.83</td>
<td>6.04</td>
</tr>
<tr>
<td>8</td>
<td>44.73</td>
<td>21.30</td>
<td>5.94</td>
<td>21.30</td>
<td>6.72</td>
</tr>
<tr>
<td>1-8</td>
<td>55.37</td>
<td>10.99</td>
<td>6.50</td>
<td>22.10</td>
<td>5.02</td>
</tr>
</tbody>
</table>

eight teachers spent a greater percentage of time asking than showing or clarifying and six of the teachers spent more time showing than clarifying.

By use of the Kendall Coefficient of Concordance, it is possible to measure the degree of association among k sets of rankings (Siegel, 1956, p. 229). After conversion of percentage data in the six categories of behavior of each teacher to ranks, the degree of association among the eight sets of ranks in the six categories was determined.
The computation of the Kendall Coefficient of Concordance is as follows:

\[ W = \frac{\sum (R_j - \frac{1}{N} \sum R_j)^2}{\frac{1}{12} k^2 (N^3 - N)} \]

where \( k \) = number of sets of rankings
\( N \) = number of entities ranked
\( R_j \) = sum of the ranks assigned to each category

(Siegel, 1956, pp. 230-231).

In Table 7 the eight sets of ranks are presented on the basis of ranks of the six major categories of teacher behaviors for each teacher.

<table>
<thead>
<tr>
<th>TABLE 7</th>
</tr>
</thead>
</table>

RANKS OF THE CATEGORIES OF Behavior ACCORDING TO PERCENTAGE OF TOTAL BEHAVIORS OF EACH TEACHER

<table>
<thead>
<tr>
<th>Teachers</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>2.0</td>
</tr>
<tr>
<td>2</td>
<td>1.0</td>
</tr>
<tr>
<td>3</td>
<td>2.0</td>
</tr>
<tr>
<td>4</td>
<td>1.0</td>
</tr>
<tr>
<td>5</td>
<td>1.0</td>
</tr>
<tr>
<td>6</td>
<td>2.0</td>
</tr>
<tr>
<td>7</td>
<td>1.0</td>
</tr>
<tr>
<td>8</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Rj  12.0  33.5  29.0  44.5  12.0  37.0
Application of the Kendall Coefficient of Concordance to the sets of ranks of Table 7 provides a result of $W = 0.80$. Where $N = 6$; the value of 0.80 for $W$ is significant at the .01 level. It can thus be concluded with considerable assurance that the agreement among the ranks of the eight teachers when based on the six categories of behavior is higher than it would be by chance.

The Kendall Coefficient of Concordance was applied also to eight sets of ranks (again representing the eight teachers) based on the seven subdivisions of "Content Development." These sets of ranks are presented in Table 8, and on the basis of this data, $W = 0.72$. Where $N = 7$, the value of 0.72 for $W$ is significant at the .01 level. Very likely, then, the agreement among the eight sets of ranks of the eight teachers when based on the subdivisions of "Content Development" is greater than it would be by chance.

In Table 9, the ranks of the subcategories of "Management" and "Affectivity" and the subdivisions of "Content Development" are presented along with "Control," "Release," and "Goal-Setting" for each teacher. These ranks are based on the percentages of the total behaviors of each teacher represented by the category, subcategory, or subdivision listed.
### Table 8

Ranks of the Subdivisions of Content Development According to Percentage of Content Development Within Each Subdivision for Each Teacher

<table>
<thead>
<tr>
<th>Teachers</th>
<th>Subdivisions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5-1</td>
<td>5-2</td>
</tr>
<tr>
<td>1</td>
<td>3.0</td>
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</tr>
<tr>
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<td>1.0</td>
</tr>
<tr>
<td>3</td>
<td>2.0</td>
<td>1.0</td>
</tr>
<tr>
<td>4</td>
<td>2.0</td>
<td>4.0</td>
</tr>
<tr>
<td>5</td>
<td>2.0</td>
<td>3.0</td>
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<tr>
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<td>4.0</td>
</tr>
<tr>
<td>8</td>
<td>4.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Rj</td>
<td>22.0</td>
<td>18.0</td>
</tr>
</tbody>
</table>

Application of the Kendall Coefficient of Concordance to the data of Table 9 provides a value of 0.74 for W. Here, N = 15, and the value of 0.74 for W is significant at the .01 level. It can thus be concluded with considerable assurance that the agreement among the eight sets of ranks of the categories, subcategories, and subdivisions of "Content Development" as presented in Table 9 is greater than would be accounted for by chance alone.
### TABLE 9

RANKS OF THE MAJOR SUBCATEGORIES AND THE SUBDIVISIONS OF CONTENT DEVELOPMENT ACCORDING TO PERCENTAGE OF TOTAL BEHAVIORS BY EACH TEACHER

<table>
<thead>
<tr>
<th>Teachers</th>
<th>1a</th>
<th>1b</th>
<th>1c</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5-1</th>
<th>5-2</th>
<th>5-3</th>
<th>5-4</th>
<th>5-5</th>
<th>5-6</th>
<th>5-7</th>
<th>6a</th>
<th>6b</th>
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</thead>
<tbody>
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<td>4.0</td>
<td>1.0</td>
<td>8.0</td>
<td>11.0</td>
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<td>10.0</td>
<td>7.0</td>
<td>5.0</td>
<td>15.0</td>
<td>9.0</td>
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<td>4.0</td>
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<td>9.0</td>
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<td>11.0</td>
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<td>11.0</td>
<td>8.0</td>
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<td>9.0</td>
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<td>11.0</td>
<td>4.0</td>
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<td>4.0</td>
<td>1.0</td>
<td>3.0</td>
<td>14.0</td>
<td>11.5</td>
<td>11.5</td>
<td>2.0</td>
<td>13.0</td>
<td>8.0</td>
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<td>7</td>
<td>3.0</td>
<td>1.0</td>
<td>5.0</td>
<td>8.0</td>
<td>10.0</td>
<td>11.5</td>
<td>2.0</td>
<td>7.0</td>
<td>6.0</td>
<td>9.0</td>
<td>15.0</td>
<td>11.5</td>
<td>4.0</td>
<td>13.5</td>
<td>13.5</td>
</tr>
<tr>
<td>8</td>
<td>6.0</td>
<td>2.0</td>
<td>3.0</td>
<td>11.5</td>
<td>9.0</td>
<td>11.5</td>
<td>7.0</td>
<td>5.0</td>
<td>4.0</td>
<td>15.0</td>
<td>11.0</td>
<td>8.0</td>
<td>1.0</td>
<td>14.0</td>
<td>13.0</td>
</tr>
</tbody>
</table>

| Rj       | 34.0|32.0|26.0|76.5| 73.0|92.0|37.0|30.0| 55.0|109.0|101.0|69.0|30.0|101.5|95.0|
Differences in behaviors of teachers

The teachers studied varied substantially in the actual percentage of time devoted to behaviors in some of the categories. By reference to Table 2, it can be seen that, in general, a relatively large percentage of the behaviors of teachers were in the first and fifth categories. It is thus not surprising to find that the magnitude of the range was the greatest within these two categories. In "Management" (the first category) the range was from 12.99 per cent for Teacher Six to 63.31 per cent for Teacher Seven. In the fifth category (Content Development), the range extended from a low of 31.62 per cent for Teacher Seven to a high of 75.13 per cent for Teacher Six.

Several additional differences can be discerned through a study of Table 3. For Teachers Two and Seven, a much greater percentage of behaviors was in "Laboratory Management" (lb) than in either "Routine Management" (la) or "Study Management" (lc). Teacher One, on the other hand, had less behaviors in "Laboratory Management" than in either "Routine Management" or "Study Management," and Teacher Six had no behaviors at all in "Laboratory Management." Four teachers devoted more time to "Study Management" than either "Routine Management" or "Laboratory Management."
and one teacher devoted more time to "Routine Management" than to "Laboratory Management" or "Study Management." The percentage of total teacher behaviors ranged from 6.23 to 19.68 for "Routine Management" (1a), from 0.00 to 45.49 for "Laboratory Management" (1b), and from 6.75 to 29.24 for "Study Management" (1c).

A study of Table 3 reveals also that some teachers had more behaviors of "Positive Affectivity" (6a) than "Negative Affectivity" (6b), and others had more behaviors of "Negative Affectivity" than "Positive Affectivity." Overall, a slightly greater proportion of "Affectivity" behaviors was encoded as negative than positive.

In Table 4, the percentage of "Content Development" comprising each of the subdivisions of "Content Development" was given. The teachers studied differed appreciably in several aspects of "Content Development." In "Knowledge" (5-2), the range was from 11.66 per cent of "Content Development" for Teacher Seven to 54.54 per cent for Teacher One. In "Scientific Process" (5-3), Teacher One had 0.55 per cent of "Content Development" while the highest figure was 25.22 per cent for Teacher Eight.

In subdivision 5-1 (Procedures), the range was from 10.65 per cent of "Content Development" for Teacher Six to 38.44 per cent for Teacher Seven. A substantial difference was noted among teachers
in subdivision 5-7 (Facilitates Communication), ranging from a low of 5.23 per cent of "Content Development" for Teacher Three to a high of 35.23 per cent for Teacher Four. The extremes for subdivisions 5-4 (Tentativeness of Knowledge), 5-5 (Generalizations), and 5-6 (Articulation of Content) were 0.00 to 4.53, 0.00 to 2.09, and 1.34 to 15.04, respectively.

In Table 5 were presented the percentages of total behaviors by teachers in the four forms of expression. The lowest figure for verbal behavior was for Teacher Seven, where only 22.33 per cent of all behaviors were encoded as verbal; the highest was for Teacher One, where 48.82 per cent were verbal. The congruent form (in which verbal and non-verbal behaviors occurred simultaneously and complemented each other) accounted for only 13.75 per cent of all behaviors of Teacher Five, but 41.11 per cent of all behaviors of Teacher Two were congruent. Non-verbal behaviors accounted for 24.04 per cent of all behaviors of Teacher Three and 53.97 per cent of all behaviors of Teacher Five. Contradictory behaviors (in which simultaneous verbal and non-verbal behaviors contradicted each other) were none or very few (0.00 to 0.45) for all teachers studied.

In Table 6, the percentages of "Content Development" were shown according to the communication acts involved. The extremes
for each of the communication acts were as follows: "States" ranged from 38.53 per cent of "Content Development" for Teacher Four to 80.04 per cent for Teacher Three; "Asks" ranged from 2.23 per cent (Teacher One) to 21.30 per cent (Teacher Eight); "Shows" ranged from 0.87 per cent for Teacher Six to 11.69 per cent for Teacher Four. For "Acknowledges," the range was from 4.79 per cent (Teacher Three) to 33.10 per cent (Teacher Six), and for "Clarifies," the extremes were 1.53 per cent (Teacher One) and 7.94 per cent (Teacher Four).

For a test of significant differences among the teachers with respect to various items of the Biology Teacher Behavior Inventory, the Kruskal-Wallis one-way analysis of variance was used. By means of this test, it was possible to examine k independent samples for likelihood that they came from the same population or from identical populations with respect to averages (Siegel, p. 184). Also, as a non-parametric test, the Kruskal-Wallis one-way analysis of variance was preferred for this study over comparable parametric tests. It was thus possible here to examine the ranks of the eight teachers on all five recording sessions for any item (such as a category or subcategory) desired, the result being a statement of the probability that the k independent samples were drawn from the same continuous population.
The computation of the Kruskal-Wallis statistic, \( H \), is as follows:

\[
H = \frac{12}{N(N+1)} \sum_{j=1}^{k} \frac{R_j^2}{n_j} - 3(N+1)
\]

where:
- \( k \) = number of samples
- \( n_j \) = number of cases in the \( j \)th sample
- \( N = \sum n_j \), the number of cases in all samples combined
- \( R_j \) = sum of ranks in \( j \)th sample (column)
- \( \sum_{j=1}^{k} \) directs one to sum over the \( k \) samples (Siegel, 1956, p.185).

In this study, then, \( k = 8 \), \( n_j = 5 \) for each sample, and \( N = 40 \). The procedure for each item (category, subcategory, or subdivision) involved conversion of the percentages (representing teacher behaviors on a given item on each of five recording sessions) to one sequence of forty ranks, summation of the five ranks in each of the eight samples (giving \( R_j \)'s), and squaring each \( R_j \). With this information, the value of \( H \) was computed for a given category, subcategory, or subdivision.

In Table 10, the value of \( H \) for each category of teacher behavior is presented.
TABLE 10

H VALUES FOR THE SIX CATEGORIES

<table>
<thead>
<tr>
<th>Category</th>
<th>H Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>18.20a</td>
</tr>
<tr>
<td>2</td>
<td>18.20a</td>
</tr>
<tr>
<td>3</td>
<td>15.19a</td>
</tr>
<tr>
<td>4</td>
<td>2.27</td>
</tr>
<tr>
<td>5</td>
<td>17.70a</td>
</tr>
<tr>
<td>6</td>
<td>14.41a</td>
</tr>
</tbody>
</table>

*aSignificant at the .05 level.

From the data in Table 10, it is evident that the value of H is significant at the .05 level for categories one, two, three, five, and six. That is, the differences in the ranks of the eight teachers, in the five categories mentioned, are not readily accounted for by chance alone.

In Table 11, the values of H are presented for the subcategories and subdivisions of the Biology Teacher Behavior Inventory as well as for the categories which do not have subcategories or subdivisions.

At the .05 level of confidence, then, it can be said that the differences in the ranks of the eight teachers with respect to "Laboratory Management" (1b), "Control" (2), "Release" (3), "Scientific
Process" (5-3), "Facilitates Communication" (5-7), and "Negative Affectivity" (6b) cannot be accounted for by chance alone.

**TABLE 11**

<table>
<thead>
<tr>
<th>Category, Subcategory, or Subdivision</th>
<th>H Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>8.33</td>
</tr>
<tr>
<td>1b</td>
<td>15.50^a</td>
</tr>
<tr>
<td>1c</td>
<td>11.45</td>
</tr>
<tr>
<td>2</td>
<td>18.20^a</td>
</tr>
<tr>
<td>3</td>
<td>15.19^a</td>
</tr>
<tr>
<td>4</td>
<td>2.27</td>
</tr>
<tr>
<td>5-1</td>
<td>3.61</td>
</tr>
<tr>
<td>5-2</td>
<td>12.73</td>
</tr>
<tr>
<td>5-3</td>
<td>16.67^a</td>
</tr>
<tr>
<td>5-4</td>
<td>4.02</td>
</tr>
<tr>
<td>5-5</td>
<td>11.96</td>
</tr>
<tr>
<td>5-6</td>
<td>11.69</td>
</tr>
<tr>
<td>5-7</td>
<td>14.61^a</td>
</tr>
<tr>
<td>6a</td>
<td>12.22</td>
</tr>
<tr>
<td>6b</td>
<td>18.27^a</td>
</tr>
</tbody>
</table>

^aSignificant at the .05 level.

**Discussion and summary**

The third hypothesis stated that some aspects of biology teacher verbal and non-verbal behavior could be identified which correlate highly for the biology teachers involved in the study. In this section, numerous aspects of biology teacher behavior
(incorporating both verbal and non-verbal behaviors) have been identified in which the teachers studied were similar and for which significant correlations were found. The third hypothesis was therefore accepted.

The fourth hypothesis stated that some aspects of biology teacher verbal and non-verbal behavior would be seen to vary substantially and could be identified as significantly different. Various aspects of substantial difference have been identified by inspection and certain significant differences have been statistically identified. On the basis of the significant differences with respect to these aspects (which incorporate both verbal and non-verbal behaviors), the fourth hypothesis has been accepted.

It was characteristic of teachers involved in this study to devote a much greater percentage of time to "Management" and "Content Development" than to behaviors in any of the other categories of the Biology Teacher Behavior Inventory (Table 2). When the percentages of time devoted to behaviors in the six categories were ranked for each teacher, it was found by means of the Kendall Coefficient of Concordance that the agreement among the ranks was higher (at the .01 level of confidence) than would be accounted for by chance alone (Table 7). It was characteristic also of all teachers
studied to devote a much greater percentage of time to teacher-centered "Content Development" than to student-centered "Content Development" (Table 3).

On the basis of only "Content Development" behaviors, it was apparent by inspection that all eight teachers studied exhibited more behaviors in "Procedures" (5-1), "Knowledge" (5-2), and "Facilitates Communication" (5-7) than at least in "Tentativeness of Knowledge" (5-4) and 5-5, "Generalizations" (Table 4). When the percentages of time within "Content Development" devoted to behaviors in the subdivisions of "Content Development" were ranked for each teacher, it was found by means of the Kendall Coefficient of Concordance that the agreement among the ranks was higher (at the .01 level of confidence) than it would have been by chance (Table 8). Furthermore, when the percentages of time devoted to behaviors in the various subcategories of the Biology Teacher Behavior Inventory and the subdivisions of "Content Development" were ranked for each teacher, it was found by means of the Kendall Coefficient of Concordance that the agreement among the ranks was higher (at the .01 level of confidence) than would be accounted for by chance alone (Table 9).
Also characteristic of the eight teachers studied was the prominence of verbal, congruent, and non-verbal behaviors as contrasted with contradictory behaviors (Table 5).

Within "Content Development," it was possible to classify all behaviors of each teacher according to the five communication acts of "Content Development." For all eight teachers studied, "States" comprised a greater proportion of "Content Development" behaviors than any other communication act and "Acknowledges" was exceeded only by "States" (Table 6).

Substantial variations among teachers in actual percentage of time spent at "Management" and "Content Development" were found (Table 2). Of the subcategories of "Management," the greatest range occurred in "Laboratory Management" (Table 3). Among the subdivisions of "Content Development," the greatest range in percentage of "Content Development" behaviors occurred in subdivision 5-2, "Knowledge" (Table 4).

When the five recording sessions of all eight teachers were ranked for each category of behavior, significant differences (at the .05 level) among the teachers studied were found by means of the Kruskall-Wallis one-way analysis of variance with respect to "Management," "Control," "Release," "Content Development," and
"Affectivity" (Table 10). In the same manner, it was found also that the teachers studied differed significantly at the .05 level of confidence with respect to "Laboratory Management" (1b), "Scientific Process" (5-3), "Facilitates Communication" (5-7), and 6b, "Negative Affectivity" (Table 11).

In addition to the analyses pertaining to categories, subcategories, and subdivisions discussed above, the forms of expression and the communication acts of "Content Development" were inspected for differences. For verbal, congruent, and non-verbal behaviors, it was found that the teacher with the highest proportion of behaviors had at least twice as large a percentage of behaviors in that form of expression as the teacher with the lowest proportion in that form of expression (Table 5). Similarly, the range of percentages of "Content Development" behaviors in each of the communication acts was such that the highest teacher in a given communication act had at least twice as large a percentage of behaviors in that communication act as the lowest teacher (Table 6).

**The Fifth and Sixth Hypotheses**

The fifth hypothesis stated that some aspects of BSCS teacher verbal and non-verbal behavior would be significantly different from those of non-BSCS teachers. The sixth hypothesis stated that BSCS
teachers would exhibit verbal and non-verbal behaviors which pro-
moted achievement of BSCS objectives to a greater degree than non-
BSCS teachers.

The results which pertain to the fifth and sixth hypotheses are
presented in three sections: (1) Differences in Behaviors between
BSCS Teachers and Non-BSCS Teachers, (2) The Relationship of
Behavior Differences between BSCS Teachers and Non-BSCS Teachers
to the Achievement of BSCS Objectives, (3) Discussion and Summary.

Differences in behaviors between
BSCS teachers and non-BSCS
teachers

In Table 12 are presented the percentages of behaviors of the
BSCS teachers and the non-BSCS teachers in the six major categories
of the Biology Teacher Behavior Inventory. It is quite evident that
the differences in percentages of predominant behaviors in each of
the categories are very small, the greatest difference being with
respect to "Management" (Category One) where the two groups of
teachers differed by 2.50 per cent of the total behaviors of each of
the two groups of teachers.
TABLE 12
PERCENTAGE OF BEHAVIORS OF BSCS TEACHERS AND NON-BSCS TEACHERS IN EACH MAJOR CATEGORY

<table>
<thead>
<tr>
<th>Teachers</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Non-BSCS</td>
<td>45.56</td>
</tr>
<tr>
<td>BSCS</td>
<td>43.06</td>
</tr>
</tbody>
</table>

In Table 13, the percentage of total behaviors is presented for each group on the basis of the subcategories of "Management," "Content Development," and "Affectivity" along with the figures for the categories "Control," "Release," and "Goal-Setting." Here, greater differences are apparent than on the basis of categories alone. In "Routine Management" (1a), the difference between BSCS and non-BSCS was 5.76 per cent, with non-BSCS spending more time at "Routine Management" than BSCS teachers. In "Laboratory Management" (1b), on the other hand, BSCS teachers exceeded non-BSCS teachers by 5.83 per cent. In each of the other subcategories, the percentages of predominant behaviors by the two groups were very similar.
### TABLE 13

PERCENTAGE OF BEHAVIORS OF BSCS TEACHERS AND NON-BSCS TEACHERS IN EACH SUBCATEGORY

<table>
<thead>
<tr>
<th>Subcategories</th>
<th>Teachers</th>
<th>Non-BSCS</th>
<th>BSCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>13.36</td>
<td></td>
<td>7.60</td>
</tr>
<tr>
<td>1b</td>
<td>14.98</td>
<td></td>
<td>20.81</td>
</tr>
<tr>
<td>1c</td>
<td>17.21</td>
<td></td>
<td>14.64</td>
</tr>
<tr>
<td>2</td>
<td>1.85</td>
<td></td>
<td>2.05</td>
</tr>
<tr>
<td>3</td>
<td>1.31</td>
<td></td>
<td>1.84</td>
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<td>4</td>
<td>0.70</td>
<td></td>
<td>0.91</td>
</tr>
<tr>
<td>5a</td>
<td>45.88</td>
<td></td>
<td>48.23</td>
</tr>
<tr>
<td>5b</td>
<td>3.40</td>
<td></td>
<td>2.18</td>
</tr>
<tr>
<td>6a</td>
<td>0.62</td>
<td></td>
<td>0.45</td>
</tr>
<tr>
<td>6b</td>
<td>0.62</td>
<td></td>
<td>1.06</td>
</tr>
</tbody>
</table>

In Table 14, the percentage of "Content Development" behaviors constituted of behaviors in each of the subdivisions of "Content Development" is presented for BSCS teachers and non-BSCS teachers.

### TABLE 14

PERCENTAGE OF CONTENT DEVELOPMENT BEHAVIORS IN EACH SUBDIVISION OF CONTENT DEVELOPMENT BY BSCS AND NON-BSCS TEACHERS

<table>
<thead>
<tr>
<th>Teachers</th>
<th>Subdivisions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5-1</td>
</tr>
<tr>
<td>Non-BSCS</td>
<td>22.97</td>
</tr>
<tr>
<td>BSCS</td>
<td>17.76</td>
</tr>
</tbody>
</table>
The magnitude of the difference between the two groups was greater in "Knowledge" (5-2), "Scientific Process" (5-3), and "Facilitates Communication" (5-7) than in "Procedures" (5-1), "Tentativeness of Knowledge" (5-4), "Generalizations" (5-5), and "Articulation of Content" (5-6). Behaviors pertaining to "Knowledge" constituted 39.57 per cent of the predominant behaviors of "Content Development" for the non-BSCS teachers but only 26.94 per cent for the BSCS teachers, a difference of 12.63 per cent. The BSCS teachers had a larger per cent of predominant behaviors devoted to "Scientific Process," however, at 17.21 as contrasted with 7.22 for the non-BSCS teachers, a difference of 9.99 per cent. The difference between the two groups with respect to "Facilitates Communication" was 11.92 per cent with figures of 31.70 per cent and 19.78 per cent for the BSCS teachers and non-BSCS teachers, respectively.

By means of the Mann-Whitney U test, it is possible to test whether two independent groups have been drawn from the same population (Siegel, 1956, p. 116). It was thus possible to measure the probability of differences between the BSCS teachers and the non-BSCS teachers on the basis of the various categories, subcategories, and subdivisions. These items incorporate both verbal and non-verbal behaviors, of course.
The procedure was to combine the frequency of predominant behaviors of each of the BSCS teachers on a given item. The same procedure was used for the non-BSCS teachers. This was done separately for each visit (or sample of behaviors) to each teacher. On a given item, then, five scores were obtained for BSCS teachers and five for non-BSCS teachers. After conversion to percentages, these scores were ranked across both groups and the ranks were used to compute the value of $U$.

The procedure for computing the value of $U$ is as follows:

$$U = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1$$

or,

$$U = n_1 n_2 + \frac{n_2(n_2+1)}{2} - R_2$$

where $n_1 =$ size of one sample,

$n_2 =$ size of the other sample,

$R_1 =$ sum of the ranks assigned to the sample whose size is $n_1$,

$R_2 =$ sum of the ranks assigned to the sample whose size is $n_2$.

The formulas presented above yield different values for $U$; the smaller value of the two is always the one used (Siegel, pp.119-120).
In Table 15 are presented the U values on the basis of BSCS teachers and non-BSCS teachers in each of the six major categories of the Biology Teacher Behavior Inventory.

**TABLE 15**

**U VALUES FOR THE SIX CATEGORIES BASED ON NON-BSCS TEACHERS AND BSCS TEACHERS**

<table>
<thead>
<tr>
<th>Category</th>
<th>U Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10.0</td>
</tr>
<tr>
<td>2</td>
<td>11.0</td>
</tr>
<tr>
<td>3</td>
<td>7.0</td>
</tr>
<tr>
<td>4</td>
<td>9.5</td>
</tr>
<tr>
<td>5</td>
<td>11.0</td>
</tr>
<tr>
<td>6</td>
<td>10.0</td>
</tr>
</tbody>
</table>

Since the fifth hypothesis, as stated, was concerned only with the detection of differences (not the direction of differences) between the BSCS teachers and the non-BSCS teachers, the measures of the probabilities of differences were of necessity based on non-directional tests. Reference to an appropriate table of probabilities revealed that none of the values for U as presented in Table 15 approached the .05 level.

Table 16 presents the U value for each of the subcategories and subdivisions of the Biology Teacher Behavior Inventory as well as for the categories which do not have subcategories or subdivisions.
Reference to an appropriate table of probabilities revealed that for a nondirectional test, none of the values of \( U \) in Table 16 reached the .05 level. The only value that approached the .05 level of probability that no difference exists (or, the .05 level of confidence that a difference does exist) was for subdivision 5-3 (Scientific Process), where \( p = .056 \).

**TABLE 16**

U VALUES FOR THE SUBCATEGORIES AND SUBDIVISIONS OF THE BIOLOGY TEACHER BEHAVIOR INVENTORY

<table>
<thead>
<tr>
<th>Category, Subcategory or Subdivision</th>
<th>U Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>4.0</td>
</tr>
<tr>
<td>1b</td>
<td>8.0</td>
</tr>
<tr>
<td>1c</td>
<td>11.0</td>
</tr>
<tr>
<td>2</td>
<td>11.0</td>
</tr>
<tr>
<td>3</td>
<td>7.0</td>
</tr>
<tr>
<td>4</td>
<td>9.5</td>
</tr>
<tr>
<td>5a</td>
<td>11.0</td>
</tr>
<tr>
<td>5b</td>
<td>11.5</td>
</tr>
<tr>
<td>5-1</td>
<td>9.0</td>
</tr>
<tr>
<td>5-2</td>
<td>7.0</td>
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<td>5-3</td>
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<td>5-4</td>
<td>6.5</td>
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<td>7.0</td>
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<td>5-6</td>
<td>6.0</td>
</tr>
<tr>
<td>5-7</td>
<td>4.0</td>
</tr>
<tr>
<td>6a</td>
<td>10.0</td>
</tr>
<tr>
<td>6b</td>
<td>10.0</td>
</tr>
</tbody>
</table>
The relationship of behavior differences between BSCS teachers and non-BSCS teachers to the achievement of BSCS objectives

The sixth hypothesis, that the teachers using BSCS materials would exhibit verbal and non-verbal behaviors which promoted achievement of BSCS objectives to a greater degree than the teachers not using BSCS materials, was dependent upon acceptance of the fifth hypothesis, that significant differences between the two groups of teachers could be detected.

In the preceding discussion, it was shown that, although some differences in percentages of predominant behaviors in sub-categories and subdivisions could be identified by inspection of the data, no significant differences at the .01 or .05 level of confidence were identified by means of the Mann-Whitney U test. Thus, no statistically significant differences were identified between the two groups that could be related to BSCS objectives.

Discussion and summary

The fifth hypothesis stated that some aspects of BSCS teacher verbal and non-verbal behavior would be significantly different from those of non-BSCS teachers. In this section, the data concerning BSCS teachers and non-BSCS teachers have been examined by
inspection and through statistical analysis. Though some specific differences were found by inspection in percentages of time devoted to behaviors in certain categories, subcategories, and subdivisions of behavior, no differences examined were found to be significant at the .01 or .05 level of confidence. The fifth hypothesis was, therefore, rejected.

The sixth hypothesis stated that BSCS teachers would exhibit verbal and non-verbal behaviors which promoted achievement of BSCS objectives to a greater degree than non-BSCS teachers. Since firm statistical support did not exist for the acceptance of the fifth hypotheses (that differences between the two groups of teachers could be detected), it was evident that there could be no authoritative interpretation of the relationship of differences to BSCS objectives. The sixth hypothesis was thus also rejected.

A study of the behaviors of the two groups of teachers on the basis of the six major categories revealed no substantial difference by inspection (Table 12) and no significant differences at the .01 or .05 level of confidence (Table 15). Similarly, statistical analysis by means of the Mann-Whitney U test revealed no significant differences between the two groups at the .01 or the .05 level on the basis of the subcategories and subdivisions of the Biology Teacher Behavior
Inventory (Table 16). The only item that approached significance was the subdivision "Scientific Process" (5-3). An inspection of the ranks of the two groups revealed that the BSCS teachers studied tended to exceed the non-BSCS teachers in this regard.

An inspection of the actual percentages of predominant behaviors in the various subcategories revealed that, of the differences that existed, the greatest differences were in "Routine Management," where the non-BSCS teachers exceeded the BSCS teachers, and "Laboratory Management," where BSCS teachers exceeded the non-BSCS teachers (Table 13). Of the differences that existed on the basis of the subdivisions of "Content Development," the greatest were with respect to "Knowledge," "Scientific Process," and "Facilitates Communication." The BSCS teachers were higher in "Scientific Process" and "Facilitates Communication;" the non-BSCS teachers were higher in predominant behaviors pertaining to "Knowledge" (Table 14).
CHAPTER V

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

This chapter is comprised of three major sections. The first incorporates a summary of the design of the study and a summary of the findings and conclusions concerning the hypotheses. The second section concerns implications of this study, and the third section deals with recommendations.

Summary

Design of the study

The purpose of this study was to achieve the following objectives:

1. To develop an instrument for the categorization of biology teacher behaviors.

2. To record behaviors and patterns of biology teacher behavior by means of utilization of the instrument on video tape recordings taken in the classroom.

3. To identify aspects of teacher behavior patterns that differ significantly among teachers and aspects that appear relatively similar or correlate highly among teachers.

147
4. To identify behaviors and/or patterns of teacher verbal and non-verbal behavior that differ significantly between BSCS teachers and non-BSCS teachers.

The method employed in this study has been detailed in Chapter III. The principal components of the method were: (1) Selection of school systems and teachers cooperating in the study, (2) The use of video tape recording equipment in the schools, (3) Development of the Biology Teacher Behavior Inventory and encoding processes, (4) Establishment of observer agreement, (5) Collection, encoding, and analysis of data.

Selection of school systems and teachers cooperating in the study

Preliminary arrangements for classroom research were made by Dr. John S. Richardson, adviser, and the researchers through Dr. Paul A. Miller, Superintendent, Cincinnati Public Schools, Mr. Robert P. Curry, Associate Superintendent, Cincinnati Public Schools, and Mr. Kenneth Vordenberg, Secondary Science Administrative Supervisor, Cincinnati Public Schools.

The biology teachers involved in the study were faculty members of several school systems of Cincinnati, Ohio, and the Greater Cincinnati area. Teachers who were invited to participate in the
study were utilized only after their voluntary indication of willingness to participate. The teachers who participated represented a wide range of schools and teaching assignments though all were secondary school biology teachers.

In the spring of 1967, at least one tape recording of each of eleven biology teachers was made. These video tapes were used in the development of the Biology Teacher Behavior Inventory. In the fall of 1967, each of eight biology teachers was video tape recorded five times. Four of the teachers were identified as BSCS teachers by their superintendent or science supervisor and four were identified as non-BSCS teachers. The data from these forty tapes were used to identify aspects of similarity and difference among the teachers and to attempt to discern differences between the BSCS teachers and non-BSCS teachers.

The use of video tape recording equipment in the schools

By using portable video tape recording equipment, it was possible to preserve a record of teacher behaviors for repeated study. Numerous technical problems were encountered in adapting the equipment to classroom use, but satisfactory solutions were developed in all cases. During data collection, attempts were made to keep bias due to the presence of observers and equipment to a minimum by
locating the equipment near the rear of the room and by establishing an agreement with teachers that specific dates and class periods for taping sessions would not be agreed upon in advance or specially prepared for.

**Development of the Biology Teacher Behavior Inventory**

Thirteen video tapes involving eleven biology teachers were utilized in instrument development. Teacher behaviors were written down in the process of replaying the video tapes. Behaviors were entered on separate index cards and the cards were grouped to formulate categories, subcategories, and subdivisions of behaviors. Through repeated trial usage of the resulting tentative category system on video tapes, refinements and gradual elimination of duplications were possible. These processes resulted in the production of definitions and glossaries for each of the categories, subcategories, and subdivisions. The resulting category system was called the **Biology Teacher Behavior Inventory**. Practice in the use of the instrument by the researchers in preparation for data collection concerning observer agreement resulted in additional refinements to the instrument.
Observer agreement

The observer agreement attempts were based on fifteen five-minute intervals of teacher behaviors selected at random from the tapes utilized in the process of instrument development and four additional five-minute intervals selected at random during actual encoding of data from the data tapes. Measurement of observer agreement was accomplished by use of the Scott Index of Inter-coder Agreement (1955). Over-all observer agreement figures were 0.92, 0.95, and 0.93, on the three major groups of observer agreement attempts.

Collection, encoding, and analysis of data

Four BSCS teachers and four non-BSCS teachers were involved in data collection during the fall of 1967. Five video tape recordings of one class period duration each were made of each of the eight biology teachers.

Encoding was accomplished by writing down symbols representing the appropriate category, subcategory, and subdivision in the appropriate columns of the Data Record based on whether the behaviors were verbal, congruent, non-verbal, or contradictory. As long as a given behavior continued, pencil dots were continued under the
appropriate symbols at approximately one-second intervals. Preliminary condensation of data was accomplished by the identification of the predominant behavior on the basis of time consumed within ten-second intervals of time.

The analysis of data involved conversion of frequencies of predominant behaviors for the various teachers and the two groups of teachers to percentages since the total number of predominant behaviors was not precisely equal for all teachers studied. These percentages were then analyzed by inspection for similarities and differences among the teachers studied and differences between BSCS teachers and non-BSCS teachers. Statistical analysis of the data employed the use of non-parametric statistical tests. For a measure of the correlation among the ranks of the eight teachers on various items, the Kendall Coefficient of Concordance was used. For a measure of significant difference among ranks of the eight teachers with respect to given items, the Kruskall-Wallis one-way analysis of variance was used. The Mann-Whitney U test was utilized for a measure of the probability that the two groups of teachers (BSCS teachers and non-BSCS teachers) came from different populations. In all cases, the .05 level of confidence was used as the criterion in testing the hypotheses.
Findings and conclusions concerning the hypotheses

In this portion of the summary, the hypotheses of this study are presented along with a summary of the findings and the conclusions concerning each hypothesis.

The first hypothesis

The first hypothesis stated that an instrument incorporating both verbal and non-verbal behaviors of biology teachers could be developed.

Summary with respect to the first hypothesis

Through inductive processes detailed in Chapter III, the Biology Teacher Behavior Inventory was developed. The three major parts of the instrument are presented in Appendixes E through G. Included are an outline of the structure of the instrument, definitions of the categories, subcategories, and subdivisions, and glossaries of behaviors. The instrument was utilized on forty video tapes of biology teacher data and was found to incorporate very nearly all the behaviors of this data influencing the teaching-learning situation. The seventh category was used very rarely and observer agreement figures were highly acceptable. Behaviors were encoded according to
form of expression (verbal, congruent, non-verbal, and contradictory) though the instrument was not limited in structure to these bases. The first hypothesis was, therefore, accepted.

Conclusion with respect to the first hypothesis

It must be concluded on the basis of this study that an instrument can be developed which incorporates verbal and non-verbal behaviors of biology teachers. Incorporation of nearly all behaviors encountered in this study is evidenced by a combination of low usage of the "Undecided" Category and high observer agreement figures. This researcher is of the opinion that the procedures used in the development of the Biology Teacher Behavior Inventory contributed substantially in providing a broad basis for the incorporation of a major proportion of all biology teacher behaviors encountered in this study.

The second hypothesis

The second hypothesis stated that an instrument meeting the requirements of the first hypothesis could be constructed on a category basis to incorporate behaviors pertinent to studies of teacher behavior with widely differing objectives.
Summary with respect to the second hypothesis

In this study, the term "category" was regarded as a major division or section of the instrument into which certain behaviors were classified and from which all other behaviors were excluded. In the process of instrument development, criteria were established for decision-making in the categorization of teacher behaviors. The criteria were developed in the context of categorization of actual teacher behaviors and constitute the definitions of the categories, subcategories, and subdivisions of the Biology Teacher Behavior Inventory as presented in Appendix F. Considerable evidence that the efforts to establish mutually exclusive categories, subcategories, and subdivisions were successful was provided by the combination of high observer agreement and low usage of the "Undecided" category. In this regard, then, the second hypothesis was accepted.

The Biology Teacher Behavior Inventory has been used in two studies whose objectives differed substantially. The biology teacher behaviors incorporated and the structure of the Biology Teacher Behavior Inventory were found to be appropriate for use in both studies; hence, the second hypothesis was accepted with respect to these two studies in this regard also.
Conclusion with respect to the second hypothesis

On the basis of this study, it is concluded that the Biology Teacher Behavior Inventory meets the requirements of a category system on the basis of the definition of "category" as used in this study. Furthermore, insofar as the usage of the Biology Teacher Behavior Inventory in the studies of Evans and Balzer provides evidence of its applicability to studies with widely differing objectives, it is concluded that the Biology Teacher Behavior Inventory incorporates behaviors that are pertinent to studies with widely differing objectives. This contention is supported also by the fact that very nearly all identifiable behaviors in this study were categorizable by means of the Biology Teacher Behavior Inventory.

The third hypothesis

The third hypothesis stated that some aspects of biology teacher verbal and non-verbal behavior which correlate highly for the biology teachers involved in the study could be identified.

Summary with respect to the third hypothesis

Various aspects of the behaviors of the teachers studied were identified as characteristic of the teachers involved in the study. All
teachers devoted substantially more time to behaviors of "Management" and "Content Development" than behaviors in the other categories of the instrument. All teachers devoted more time by far to teacher-centered "Content Development," than to student-centered "Content Development," and all teachers studied exhibited more "Content Development" predominant behaviors in "Procedures," "Knowledge," and "Facilitates Communication" than in "Tentativeness of Knowledge" and "Generalizations." The agreement among ranks of all eight teachers on the categories, on the subdivisions of "Content Development," and on the subcategories, subdivisions of "Content Development," and categories two, three, and four was higher in each case (at the .01 level of confidence) as examined by the Kendall Coefficient of Concordance than would be accounted for by chance. Of the communication acts within "Content Development," it was apparent by inspection that for each of the eight teachers studied, "States" was the most prevalent communication act and "Acknowledges" was exceeded only by "States." Various other similarities among the teachers are detailed in Chapter IV. The third hypothesis was thus accepted.
Conclusion with respect to the third hypothesis

It is concluded on the basis of the analyses carried out in this study that some aspects of the behaviors encountered in this study which correlate highly for or are characteristic of these teachers can be identified. The aspects that are the most evident are the similarities in pattern with respect to ranks of the various categories, subcategories, and subdivisions on the basis of percentages of predominant behaviors. Thus, the relationships of the categories to each other, on the basis of time spent in behaviors in each category, are very similar among the various teachers. Such similarities are also highly significant when based on the subdivisions of "Content Development" and when based on the subcategories of "Management" and "Affectivity," the categories of "Control," "Release," and "Goal-Setting," and the subdivisions of "Content Development" when all are ranked together for each teacher. It is concluded also that in this study the teachers studied exhibited more predominant behaviors of "Content Development" in which the communication act was "States" than any other communication act, and that "Acknowledges" was exceeded only by "States." Thus, when the major categories are considered, the teachers studied are quite similar with respect to the ranks of the categories on the basis of the percentage of
predominant behaviors in each category. The similarity is also evident and significant with respect to ranks of subdivisions of "Content Development" and when the subcategories of "Management" and "Affectivity," the categories of "Control," "Release," and "Goal Setting," and the subdivisions of "Content Development" are all ranked together.

**The fourth hypothesis**

The fourth hypothesis stated that some aspects of biology teacher verbal and non-verbal behavior would be seen to vary substantially and would be identifiable as significantly different.

**Summary with respect to the fourth hypothesis**

Numerous sources of substantial variation and significant difference in the behaviors of the biology teachers were found in this study. With respect to the major categories, the greatest ranges of difference among teachers were in "Management" and "Content Development." The teachers were found to differ significantly (at the .05 level of confidence), however, with respect to each of the six major categories except "Goal Setting." The subcategories and subdivisions in which the eight teachers differed significantly at the .05 level were "Laboratory Management," "Scientific Process,"
"Facilitates Communication," and "Negative Affectivity." A large range of percentages was identified also among teachers with respect to "Procedures" and "Knowledge," but the differences were such as to be quite readily accounted for by chance. With respect to each of the forms of expression and each of the communication acts within "Content Development," the teacher with the highest proportion of behaviors had at least twice as large a percentage of behaviors as the lowest teacher. On the basis of the various significant differences identified, the fourth hypothesis was accepted.

**Conclusion with respect to the fourth hypothesis**

It must be concluded on the basis of the results of this study that some aspects of the behaviors involved in this study differ significantly among the teachers studied. Differences in percentages are evident in almost all respects, as would be expected, but various differences are not readily accounted for by chance alone. It is thus concluded that while gross similarities are found among all the teachers studied (such as those based on the ranks of the six major categories), the teachers studied nevertheless differ significantly within some of the items, such as a given category or subcategory, with respect to the behaviors involved in this study.
The fifth hypothesis

The fifth hypothesis stated that some aspects of BSCS teacher verbal and non-verbal behavior would be significantly different from those of non-BSCS teachers.

Summary with respect to the fifth hypothesis

No significant differences were found between the BSCS teachers as a group and the non-BSCS teachers on the basis of examination of categories, subcategories, and subdivisions by means of the Mann-Whitney U test. The only item that approached significance at the .05 level was "Scientific Process." By inspection, it was evident that BSCS teachers were somewhat higher in this respect than non-BSCS teachers. The other items of the Biology Teacher Behavior Inventory in which considerable differences between the two groups on a percentage basis were observable by inspection were "Routine Management," "Laboratory Management," "Knowledge," and "Facilitates Communication." None of these differences were so distributed as to differ significantly from chance. The fifth hypothesis was, therefore, rejected.
Conclusions with respect to the fifth hypothesis

It is concluded that the behaviors studied do not differ significantly with respect to those aspects that were statistically analyzed when the BSCS teachers and the non-BSCS teachers studied are compared. It should be noted again that the difference between the two groups very closely approached significance with respect to "Scientific Process;" hence, it may be that evidence in this regard should be considered quite inconclusive. It is clear, however, that firm statistical support does not exist for the acceptance of the fifth hypothesis on the basis of the analyses completed in this study. Seemingly substantial differences can be identified by inspection in "Routine Management," "Laboratory Management," "Procedures," "Knowledge," and "Facilitates Communication," but these differences are distributed in such a manner as to be fairly readily accounted for by chance.

The sixth hypothesis

The sixth hypothesis stated that BSCS teachers would exhibit verbal and non-verbal behaviors which would promote achievement of BSCS objectives to a greater degree than non-BSCS teachers.
Summary with respect to the sixth hypothesis

Acceptance of the sixth hypothesis was dependent, in part, upon acceptance of the fifth hypothesis, that some aspects of BSCS teachers' verbal and non-verbal behavior would be distinguishable from those of non-BSCS teachers. In the discussion concerning the fifth hypothesis, it was shown that it was not possible to accept the fifth hypothesis on the basis of the findings of this study. Thus, there appeared to be no sound basis on which to attempt to relate "differences" to the achievement of BSCS objectives. The sixth hypothesis was, therefore, rejected.

Conclusion with respect to the sixth hypothesis

On the basis of the data and the statistical analysis of this study, it is concluded that the behaviors of the BSCS teachers were not significantly different from the behaviors of the non-BSCS teachers. In the absence of any such differences, it is concluded also that the behaviors of the BSCS teachers as analyzed in this study cannot be interpreted as promoting achievement of BSCS objectives to a greater degree than the behaviors of the non-BSCS teachers.
Implications

**Implications of findings concerning the hypotheses**

In this study, the sample of teachers under study was limited in size and not randomly selected. The conclusions concerning the hypotheses have been limited to the sample studied; certainly generalizations to other teachers, biology teachers, or even BSCS teachers and non-BSCS teachers are not warranted on the basis of the limited information obtained in this study. In the statements that follow, the researcher has attempted to place the findings into the proper perspective with respect to projected situations, larger samples, or populations.

**The first and second hypotheses**

It can be inferred, that, given a sample of biology teachers, an instrument, constructed on a category basis, can be developed through the procedures here utilized, which incorporates the behaviors in various forms of expression of those teachers effectively. There is a bit of evidence also, since one teacher present in the study sample was not present in the instrument development sample, that the behaviors of other teachers may be effectively incorporated by an instrument so developed. Furthermore, it can be inferred that the behaviors incorporated by an instrument so developed (given a certain sample of behaviors) are appropriate for some studies whose objectives differ. For some studies, modifications in the structure of the instrument
might be desirable, and it is possible that the structure of the instru­
ment might differ somewhat from its present form if based on other 
teacher or behavior samples. Nevertheless, it can be inferred that the 
procedures employed here are productive in providing records of be­
haviors appropriate for study, even though the objectives for such 
study may vary.

The third and fourth hypotheses

In this study, various aspects concerning the behaviors of the 
biology teachers were identified as characteristic of the teachers in 
this study. Other aspects were identified in which the teachers in­
volved differed significantly. It cannot be assumed that all teachers 
exhibit the same similarities and differences nor that these teachers 
would exhibit precisely the same similarities and differences on every 
possible sample of behaviors. Nevertheless, since certain similari­
ties and differences were identified which were not readily accounted 
for by chance, it would seem that some patterns and relationships of 
behaviors may exist whose further analysis and description could be of 
value in the study of the teaching and learning of science. On the 
basis of the evidence resulting from this exploratory study, it is 
suggested that the procedures used in the development of the Biology 
Teacher Behavior Inventory, the instrument itself, and the exploratory 
use thereof offer promise for further study of biology teacher behavior.
The fifth and sixth hypotheses

No significant differences between the BSCS teachers and the non-BSCS teachers were found with respect to items analyzed in this study. Though differences in behaviors may exist at certain times and between certain BSCS teachers and certain non-BSCS teachers, it appears from the results of this study that significant differences between two such groups of teachers, at least with respect to the items of the Biology Teacher Behavior Inventory analyzed in this study, should not be assumed. It cannot be inferred from the results of this study whether significant differences, if they existed, would be such as to indicate that the behaviors of the BSCS teachers promoted achievement of BSCS objectives to a greater degree than those of teachers not using BSCS materials.

It is of some interest to compare these findings and implications with those of Kochendorfer (1966), Barnes (1966), and Gallagher (1967). Both Kochendorfer and Barnes reported finding significant differences between BSCS teachers and non-BSCS teachers on the basis of questionnaires completed by the students. Gallagher, on the basis of his study of BSCS teachers in the classroom, reported that there was no such thing as a BSCS curriculum presentation in the schools, but rather individual interpretations of BSCS (1967, pp. 11-14). The findings and implications of the present study, then, would seem more nearly in accord with those of Gallagher than those of
Kochendorfer and Barnes. It may be that the criteria for, or procedures involved in, the selection of the teachers involved in the studies of Kochendorfer and Barnes differed enough from those of the present study to account for the differences in findings.

**Supplementary Implications**

**The use of video tape recording equipment.**

From the experiences of the researchers in the research activities of which this study was a part, it is inferred that the use of video tape recording equipment in the classroom has considerable potential. Opportunities for intensive behavioral research are greatly enhanced. In this study, it was only because of the ability to stop and replay sequences of behavior that it was possible to develop a second-by-second running account of teacher behavior. Thus, in turn, an objective basis for the identification of predominant behaviors over ten-second intervals was provided. It is this writer's contention that such a comparatively specific and objective basis enhances the scientific quality and the productivity of the inductive process as used in this study in the development of the *Biology Teacher Behavior Inventory* and in the encoding and condensation of data.

**Inductive processes employed in this study.**

Numerous previous attempts at instrument development have been initiated on bases that were at least partially deductive. That
is, dimensions and categories have been logically developed at least partially on the basis of certain theoretical frameworks structured prior to extensive observation of classroom behaviors. Some of these studies have been quite productive and the approaches based on the various theoretical frameworks have correspondingly provided various kinds of information. It is here suggested, however, that an instrument inductively developed from the outset may be less subject to omission of certain behaviors not thought of by the researcher and to bias because of predication upon predetermined concerns regarding teacher and/or pupil behaviors than a deductively developed observational system.

In this study, evidence of the adequacy of the inductive method of instrument development was provided in the breadth of the structural basis so developed. Nearly all behaviors identified in data collection were categorizable in the Biology Teacher Behavior Inventory, regardless of form of expression. Furthermore, observer agreement figures were highly acceptable and the "Undecided" category was used very seldom. On the basis of the effectiveness of the inductive approach as utilized in this study in instrument development, it may be inferred that this method has considerable potential in teacher behavior research.
Method of encoding teacher behaviors

In this study, three features concerning the encoding of teacher behaviors seem to have implications for research. They are as follows:

1. The use of the Data Record for encoding teacher behaviors. In this manner, forms of expression (verbal, congruent, non-verbal, and contradictory) can be incorporated into the record of teacher behaviors without limitation of the description of behaviors strictly to forms of expression. Thus, it is possible to categorize behaviors in terms of behavioral intent and effect while nevertheless obtaining information concerning forms of expression.

2. Encoding of on-going teacher behaviors on a second-by-second basis. Through the use of this technique a detailed written account describing teacher behaviors in context is made available; both the sequence of behaviors and a very precise measure of time involved in the behaviors is thus available for study. Very likely the procedures for realizing the full potential of the richness of such records of teacher behaviors have not yet been adequately explored.

3. Condensation to predominant behaviors. In order to obtain statistically manageable data, the second-by-second record of behaviors was condensed to predominant behaviors. These were
identified on the basis of elapsed time in ten-second intervals. The predominant behaviors thus represented ten-second intervals and provided the basis for analyses and statistical calculations in this study. From a scientific standpoint, this would seem to be a more desirable approach than the subjective judgment of predominance of behaviors over intervals of time by an observer of teacher behaviors.

The prominence and nature of non-verbal behaviors

Some of the earlier studies of teacher behavior have either assumed or argued the relative unimportance of non-verbal behaviors. Illustrative are the studies of Flanders (1960), Smith (1966), Withall (1949), and Bellack (1965). Hughes stated that non-verbal behaviors were incorporated when they could be reliably obtained (1963, p. 26). In the present study, no judgments concerning use of non-verbal behaviors or the reliability of encoding certain behaviors were made; all behaviors which influenced the teaching-learning situation, regardless of the form of expression, were encoded on the Data Record as verbal, congruent, non-verbal, or contradictory. On the basis of the data of Table 5, it is apparent that the non-verbal form of expression was actually involved in a majority of all behaviors encoded for all eight teachers. When congruent, non-verbal, and
contradictory behaviors are included, it becomes evident that 65.22 per cent of all behaviors involved the non-verbal form of expression. On the basis of this evidence it is inferred that non-verbal behaviors may be of considerable importance in teacher behavior, and should be further investigated rather than ignored or assumed as unimportant.

Both Flanders (Amidon and Flanders, 1963) and Parakh (1965) developed items of their respective instruments constituted of silence. Through the inductive processes of this study and on the basis of behavioral intent and effect, no such category of behaviors was found to occur. In other words, behaviors were not seen as "silence;" rather non-verbal behaviors functioned in various of the same categories, subcategories, and subdivisions as the verbal behaviors.

Recommendations for Further Study

1. The Biology Teacher Behavior Inventory should be used with other samples of behaviors and other biology teachers for more information concerning the adequacy of the instrument in incorporating all behaviors encountered. Eventually the feasibility of extension of the Biology Teacher Behavior Inventory to use with science teachers other than biology should be explored as well.

2. In this study, "Management" constituted a relatively high percentage of all behaviors encoded. Although three subcategories
of "Management" are provided in the Biology Teacher Behavior Inventory, it may be that more detailed analysis of the behaviors constituting this relatively large proportion of teacher behaviors would yield productive information.

3. In the future, additional attention should be given to the development of new methods for processing of data. In this study, predominant behaviors were identified on the basis of time consumed within ten-second intervals of time. The possibility of incorporating directly all data encoded on a second-by-second basis into actual analysis should be explored. If adequate bases could be developed, weighting of behaviors might eventually also be helpful in addition to the elapsed time element in the identification of predominant behaviors.

4. Evidence has been presented that non-verbal behaviors may be much more prominent than many researchers have suggested in the past. Future studies should incorporate attention to non-verbal behaviors; analysis from the standpoint of behavioral function may be more productive than superficial description (such as "silence").

5. Very few "Contradictory" behaviors were encoded. Additional studies giving attention to this aspect would be desirable since there is a possibility that this finding is due, in part, to insensitivity to contradictory behaviors by the observers.
6. Various aspects have been identified in which the
teachers, on the basis of the behaviors involved in this study, were
very similar. In other respects, the teachers were significantly
different. Additional studies should be carried out in order to ascer­
tain similarities and differences on a broader basis. Perhaps
eventually certain variables will be associated with certain similarities and certain differences.

7. It was not possible to distinguish the BSCS teachers and
the non-BSCS teachers as representing different populations. It
should be reemphasized that the identification of BSCS teachers by
administrators or science supervisors of the school systems involved
was accepted for the purposes of this study. If significant differ­
ences could be reliably identified between BSCS teachers and non­
BSCS teachers, it would be helpful eventually also to identify
variables associated with such differences.

8. The use of video tape equipment has great potential in
education. Both in pre-service and in-service education, the study
of teacher behaviors can now be pursued in great detail. The in­
creased availability of objective feedback to teachers should be
utilized to full advantage. In research, greater specificity and ob­
jectivity in the study of classroom behavior now seem to be possible.
Perhaps most important, it is now possible to view a given record of classroom behaviors numerous times. One of the prospects thus opened up to research is the opportunity to analyze the same behaviors more than once, perhaps using different instruments or various portions of a complex instrument. In this context and with these opportunities, it should become possible to learn a great deal more about the classroom teaching-learning situation than has hitherto been possible.

9. In the writer's opinion, the inductive processes utilized in the development of the Biology Teacher Behavior Inventory were highly productive. With the advantages of video tape equipment and the benefit of replay of teacher behaviors available, additional studies, inductive in approach from the outset, should be carried out to explore further the potential of this approach for objective and unbiased analysis of classroom behavior.
APPENDIX A

A GENERAL DESCRIPTION OF REQUESTED RESEARCH

RESOURCES AND OPPORTUNITIES
A General Description of Requested Research
Resources and Opportunities

addressed to

The Cincinnati, Ohio, Public Schools

by John S. Richardson

The need for improved teacher performance is perhaps more evident today than ever before. With the continuing emphasis on the role of science in our society and the reflected emphasis in the school classroom, we are facing continuing calls for more effective science teachers and for the evidence that teachers are actually more effective in their teaching activities than ever before.

Currently, there is evidence that the behaviors of the science teachers can be related to their competence in its more specific aspects and to the overall quality of their teaching; furthermore, it can be related to the achievement of the pupils for whom they have responsibility. In fact, the behaviors of the teachers can be and have been directly related to the behaviors of the pupils as they study and learn.

However, such studies of interaction analysis are only in their beginning. While some few have been completed in the field of science education, many more will be needed before generalizations can become as trustworthy as our profession will require. One
complexity enters the teaching of science in a way that some fields
do not face so directly, if at all. The dependence of science teaching
upon the use of the laboratory and other experience approaches
involves a dimension of teaching that will eventually require fairly
complex research procedures. For example, the earlier studies in
interaction analysis attempted to base the analysis on verbal be-
havior only. Currently the research efforts at The Ohio State
University are attempting to include in part an analysis of non-verbal
behavior as well as verbal behavior in the teaching of science.

At this point in our research, we are particularly concerned
with studies, details of which will be presented by the investigators
as their research designs are extended and realized in the general
fields of biological science and physics in the secondary schools.
At this point we have need of sequential recordings on video tape
and a certain number of audio tapes, also, to the extent of a number
in the range of five to ten separate recordings over a period of time
for each of six or eight teachers in the above fields that would be
developed in relation to the availability of the personnel and upon
the class schedule. We do not anticipate at this time that any
separate testing of the pupils would be involved, thus making no re-
quest for use of instructional time as a part of the program.
APPENDIX B

POST-DATA COLLECTION LETTER OF RECOGNITION
AND APPRECIATION
Dear Mr. ________:

The video tape recording of various Cincinnati area biology teachers has now been completed. We, in Science Education at The Ohio State University, express our sincere appreciation and gratitude for your participation in our research project. The cooperation of all administrators, science supervisors, and teachers has been outstanding. We feel that this joint effort is illustrative of the kind of ideal cooperation necessary for progress in our profession. Such cooperation facilitates research and shortens the communication gaps which sometimes exist between institutions of higher learning and the public schools.

We express our appreciation to the following science supervisors for their generous contribution of time and energy in showing us to the various schools and introducing us to teachers.

Mr. Jerome L. Braun, Cincinnati Public Schools
Mr. Edwin M. Smith, Cincinnati Public Schools
Mr. Kenneth E. Vordenberg, Cincinnati Public Schools
Mr. Charles V. Wojcik, Indian Hills High School

We realize that our requests placed an additional burden on their work schedules. Particular thanks is due Mr. Kenneth Vordenberg for aid in arranging a great many details which are always part of such a cooperative effort.

Above all, the biology teachers deserve our thanks. Each of the following teachers has been video tape recorded five times during the fall of 1967:

Mrs. Margaret L. Branstrattor, Walnut Hills High School
Mr. Haralambos Fekkos, Withrow Junior High School
Mr. David L. Garwood, Roberts Junior High School
Mr. Charles H. Henderson, Aiken High School
Mr. Charles R. Kindler, Aiken High School
Mrs. Carolyn S. Murphy, Indian Hills High School
Mrs. Joan J. Stanley, Walnut Hills High School
Mr. Charles V. Wojcik, Indian Hills High School
We express, also, our appreciation to those teachers who participated in the taping sessions during the spring of 1967. In addition to most of the persons mentioned above, each of the following teachers was video taped at least once during the spring.

Mr. Joseph M. DePollo, Heinold Junior High School
Mr. Charles Hartley, Madeira High School
Mrs. Lillian McElroy, Mariemont High School
Mr. Joe S. Wilder, Cutter Junior High School

When the research studies have been completed, abstracts of findings will be made available to each of the persons who cooperated in the study.

Cordially,

Dr. John S. Richardson  Mr. Thomas P. Evans
Adviser  Researcher

Mr. LeVon Balzer
Researcher
APPENDIX C

DATA RECORD
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<th>Non-Verbal</th>
<th>Contradictory</th>
<th>Predominant Behavior</th>
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APPENDIX D

MASTER DATA RECORD
### MASTER DATA RECORD

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APPENDIX E

BIOLOGY TEACHER BEHAVIOR INVENTORY

CATEGORIES OF TEACHER CLASSROOM BEHAVIOR
CATEGORIES OF TEACHER CLASSROOM BEHAVIOR

1. Management
   a. Routine Management
   b. Laboratory Management
   c. Study Management

2. Control

3. Release

4. Goal Setting

5. Content Development
   a. Teacher Centered
      1) Procedures
         a) states
         b) asks
         c) shows
         d) acknowledges
         e) clarifies
      2) Knowledge
         a) states
         b) asks
         c) shows
         d) acknowledges
         e) clarifies
      3) Scientific Process
         a) states
         b) asks
         c) shows
4) Tentativeness of Knowledge
   a) states
   b) asks
   c) shows
   d) acknowledges
   e) clarifies

5) Generalizations
   a) states
   b) asks
   c) shows
   d) acknowledges
   e) clarifies

6) Articulation of Content
   a) states
   b) asks
   c) shows
   d) acknowledges
   e) clarifies

7) Facilitates Communication
   a) states
   b) asks
   c) shows
   d) acknowledges
   e) clarifies

b. Student Centered

1) Procedures
   a) states
   b) asks
   c) shows
d) acknowledges
e) clarifies

2) Knowledge

a) states
b) asks
c) shows
d) acknowledges
e) clarifies

3) Scientific Process

a) states
b) asks
c) shows
d) acknowledges
e) clarifies

4) Tentativeness of Knowledge

a) states
b) asks
c) shows
d) acknowledges
e) clarifies

5) Generalizations

a) states
b) asks
c) shows
d) acknowledges
e) clarifies

6) Articulation of Content

a) states
b) asks
c) shows
d) acknowledges
e) clarifies
7) Facilitates Communication
   a) states
   b) asks
   c) shows
   d) acknowledges
   e) clarifies

6. Affectivity
   a. Positive Affectivity
   b. Negative Affectivity

7. Undecided
APPENDIX F

BIOLOGY TEACHER BEHAVIOR INVENTORY

DEFINITIONS OF THE CATEGORIES AND SUBCATEGORIES OF TEACHER CLASSROOM BEHAVIOR
DEFINITIONS OF THE CATEGORIES, SUBCATEGORIES AND SUBDIVISIONS OF TEACHER CLASSROOM BEHAVIOR

Category 1: Management: Those behaviors that regulate the routine "housekeeping" activities which are used in the operation of the biological science classroom. In addition, this category includes those behaviors in which the teacher makes assignments, since those behaviors comprise an aspect of management in the learning situation.

a. Routine Management: Those behaviors of the teacher associated with the routine management of any classroom. Behaviors involved in the control of the physical environment and the execution of administrative details are illustrative of this subcategory.

b. Laboratory Management: Those behaviors of the teacher associated with preparation for, maintenance and supervision of, or cleanup from biological science laboratory, demonstration, or classroom activities.

c. Study Management: Those behaviors of the teacher which specify assignments or provide for directed study. The achievement of these assignments is
presumably intended to facilitate achievement of content objectives. Behaviors from which other intentions for assignments are inferred (such as control) are categorized according to the primary intent.

Category 2: **Control:** Those behaviors that intend to make the classroom activities more orderly or formal. They tend to structure, regulate or otherwise keep student behavior and attention within limits, i.e., teacher behaviors that intend to have the students follow a recommended course of action.

Category 3: **Release:** Those teacher behaviors that intend to make student behavior less formal and orderly. They tend to allow greater student control of attention and discipline, i.e., those teacher behaviors that increase informality and permissiveness in the classroom.

Category 4: **Goal Setting:** Those behaviors which deal with the stating, explaining, implying, or clarifying of the purposes or goals for a given individual or classroom activity.

Category 5: **Content Development:** Those behaviors dealing primarily
with subject matter in the science classroom. These behaviors are based upon efforts to achieve objectives related to content whether they are cognitive, psychomotor or affective.

a. **Teacher Centered** vs. b. **Student Centered**:

It is useful to consider the classroom as teacher centered when the attention of most students is on the teacher or the teacher is attempting to obtain the attention of most students in the classroom. In addition, behaviors comprising teacher assertiveness in relation to individual students or groups of students are teacher centered even though the remainder of the students may be involved in student centered activities.

1) **Procedures**: Those behaviors of the teacher concerned with instruction in procedural aspects of the content. Illustrative are behaviors involved in instruction in laboratory procedures and procedures in problem solving.

2) **Knowledge**: Those behaviors of the teacher
which pertain to giving and receiving information at low cognitive levels. The principal concern is that of knowledge of specific aspects of content such as facts, definitions, and terminology as contrasted with interpretation, extrapolation, application, analysis, synthesis, observation, and evaluation.

3) **Scientific Process:** Those behaviors of the teacher which pertain to such cognitive processes as observation, interpretation, extrapolation, application, analysis, synthesis, and evaluation as contrasted with knowledge of relatively specific information such as facts, definitions, and terminology.

4) **Tentativeness of Knowledge:** Those behaviors in which the teacher states or distinctly implies a state of change regarding scientific knowledge.

5) **Generalizations:** Those behaviors which are of considerable scope or breadth as contrasted with
specificity and depth of other content considerations being undertaken by the teacher. Operationally, these behaviors may be explicitly described by the teacher or may be identified by the observer on the basis of his acquaintance with teacher behavior and the content under consideration.

6) **Articulation of Content:** Those behaviors through which the teacher attempts to establish continuity across topical areas or time. Articulation and integration of topical areas may be within biology or between biology and other areas of knowledge. When generalizations or summariizations are used as means of articulation and integration of content, the behaviors are classified on the basis of the latter intent.

7) **Facilitates Communication:** Those behaviors in which the teacher attempts to make clear and distinct the nature of communication. These can be distinguished from explanations and illustrations of content as such in that the latter
pertain to examples and elaborations, given to aid understanding of the nature of the content. Hand motions and voice pitch intended to draw attention to content are seen as facilitating communication. However, when such non-verbal behaviors illustrate content, they must be categorized as such, not as facilitation of communication.

Category 6: Affectivity: Those behaviors that intend to elicit and reinforce, positively or negatively, contributions to the teaching-learning process by an individual or group of students.

a. Positive Affectivity: Those behaviors that elicit and reinforce, in a positive manner, contributions by an individual or group of students to the teaching-learning process. These behaviors take the form of teacher recognition, encouragement, and/or praise; they are based on the positive aspects of teacher motivation and evaluation.
b. **Negative Affectivity:** Those behaviors that elicit, correct and reinforce, in a negative manner, contributions by an individual or group of students to the teaching-learning process. These behaviors take the form of corrective feedback, criticism, reprimands, accusations, admonition, and/or willful disregard; they are based on the negative aspects of teacher motivation and evaluation.

**Category 7: Undecided:** Those behaviors whose intent cannot be inferred and categorized into the other categories in the system.
APPENDIX G

BIOLOGY TEACHER BEHAVIOR INVENTORY

GLOSSARY OF TEACHER CLASSROOM BEHAVIORS
GLOSSARY OF TEACHER CLASSROOM BEHAVIORS

The following glossary is not exhaustive with respect to the definitions of behaviors in the categories and subcategories. It provides the descriptive definitions of the various categories and subcategories as seen by reviewing the pilot tapes. Duplications in the glossary are accounted for by the fact that the observer must categorize behaviors on the basis of context and inferred behavioral intent.

1. Management
   a. Routine Management
      1. Erases and/or washes chalk board
      2. Calls roll (verbal and non-verbal)
      3. Opens or closes windows and/or doors
      4. Passes out papers or gives papers to student to pass out
      5. Takes up papers or asks students to take up papers
      6. Adjusts lighting
      7. Looks for or readies materials or papers
      8. Pulls down movie screen
      9. Takes care of administrative details (signs notes,
talks to visitors, prepares absence slips, and admits tardy students)

10. Moves and/or reorganizes furniture

11. Shuffles paper during school announcement

12. Sends student on errand

13. Announces or explains school events

14. Gives several grades on request

15. Washes hands

16. Sharpens pencil

17. Mentions that exams or papers are available for those interested

18. Asks for lost articles

19. Waits for class to arrive or for bell to ring

20. Watches time

b. Laboratory Management

1. Looks for or readies supplies or equipment

2. Asks students to clean up or to turn off equipment

3. Tells students how to get information; gives sources of information

4. Shows, provides, or directs pupils to materials, supplies, and equipment
5. Reads instructions

6. Asks student needs of materials

7. Aids individual students with specific techniques

8. Shouts instructions to entire class while class works

9. Observes or supervises laboratory activities

c. Study Management

1. Asks student about make-up test or assignment

2. Gives make-up test to individual student

3. Gives, explains, repeats, implies or reminds students of assignments

4. Assigns reading (aloud or directed study)

5. Refers students to specific page in textbook

6. Gives assignment and time for directed study; also observes or directs study

7. Asks student to make a diagram on the chalk board

8. Tells students to make copies of the diagrams on the chalk board

9. Assigns or reminds students of quiz or examination

10. Calls attention to displays

2. Control

   a. Looks up from work
b. Silence

c. Stops walking

d. Indicates inability to hear due to classroom noise

e. Postpones student question or statement

f. Shoo's or places finger to lips

g. Points student to his seat

h. Holds out hands to request students to wait

i. Turns and stares

j. Taps pencil

k. Raises brow or uses eyes to gain attention

l. Stands with hands on hips and stares in silence

m. Holds up hand(s)

n. Rubs brow or grabs head

o. Walks to front of room or to door as the bell rings

p. Walks from seat to seat and inspects work

q. Records in grade book while student reports

r. Scans room to see who is not working

s. Uses sarcasm to control student(s)

t. Stares at individual student (eye contact)

u. Adjusts apparatus for student without being asked

v. Asks student to report after class

w. Comments on appropriateness of combing hair in public
x. Watches carefully the interchange between two students
y. Studies or stares at student giving a report
z. Maintains or returns to authoritarian position (behind desk or demonstration table, at door or in front of room)
aa. Walks back and forth behind students
bb. Waves hands to get attention
c. Cautions student on his behavior
dd. Moves toward students who are noisy
ee. Refers to handout about term paper
ff. Tells students to draw
gg. Gives instruction for handout
hh. Gives instructions regarding written work
ii. Tells students when to turn work in
jj. Tells students to proceed with work
kk. States or asks:
   1) "Take your seats"
   2) "The bell has rung"
   3) "You are too noisy"
   4) "Time is running out"
   5) "Five more minutes"
   6) "Some people are still talking"
7) "Get busy"
8) "Give me your attention"
9) "Let's keep it quiet"
10) "Sit down"
11) "Get rid of those things, will ya"
12) "Too much competition"
13) "Put away your books"
14) "COME ON"
15) "Shut up"
16) "If you don't be quiet ..."
17) "I just want the answer"
18) "Get into your groups"
19) "Start your homework"
20) "Get the microviewers"
21) "Work on this for ... minutes"
22) "Attention class"
23) "Pay attention"
24) "One at a time"
25) "I really didn't expect Bill to cooperate"
26) "Hurry up"
27) "Will YOU cooperate?"
28) "What's the trouble here?"
29) "You must participate"
30) "Taste this"
31) "Quit messing around"
32) "Some are not paying attention"
33) "Get back where you belong"
34) "You're going to ruin it"
35) "What are you doing now, David?"
36) "Quiet"
37) "Move back"
38) "What's your problem?"
39) "Finished?"
40) "Tom, where are you supposed to be?"
41) "Are you in this class? Well, take part"
42) "If everybody would accept his own responsibility"
43) "You should already know this"

3. Release

a. Laughs, smiles, jokes or teases
b. Removes formal barriers and shortens formal distance
   (moving from behind desk when talking informally, etc.)
c. Chats informally with student(s)
d. Ignores or tolerates student noise
e. Gives students a choice of things to do
f. Encourages student talk and participation
g. Allows and encourages discussion among students
h. Ignores control
i. Uses humor
j. Accepts student jokes
k. Offers own materials for student use
l. Draws cartoon or joke on board or overhead
m. Encourages students to select their own committee and committee officials
n. Stops talking to receive student statement
o. Moves around room talking informally and giving aid when students ask for it
p. Asks for student help
q. Accepts student's correction or criticism
r. Asks for volunteers
s. Corrects own mistake or apologizes for error made earlier
t. Admits lack of knowledge or understanding in certain area
u. Lays hands on student
v. Approaches student who is talking
w. Sits on desk
x. Uses sarcasm concerning self
y. Leans toward class as he talks
z. Raises hand during student discussion
aa. Uses sarcasm as joke, laughs
bb. Uses a sweeping motion with hands to elicit response
c. Asks one student to give another assistance
dd. States or asks:
   1) "Any questions?"
   2) "Are you sure?"
   3) "Everyone understand?"
   4) "Are you with us?"
   5) "Other questions?"
   6) "Do you see that?"
   7) "How many think...?"
   8) "Want the same kind of problem or a harder one?"
   9) "How many understand?"
  10) "How many are lost?"

4. Goal Setting
   a. States the purpose of a particular class activity
   b. Reviews the major objectives of a given exercise
   c. Re-phrases the objectives of an exercise
   d. Justifies an area of study
e. Points out the results of studying certain areas of information

f. Refers to a concept as the most important in the whole world

g. Asks about the significance of a certain fact

h. Emphasizes the importance of a topic

i. Places emphasis on certain topics of a student's report, statement or question

j. Marvels at man's accomplishments

k. Notes that photosynthesis is not an accomplishment of man

l. Refers to man's starvation

m. Asks question about the effect of human actions, decisions

n. Asks question about man in general

o. Refers to human life as a natural resource

p. Relates content to local community situation

q. Relates content to current events

r. Relates content to government

s. Relates content to lives of students in class, home

5. Content Development

   a. Teacher Centered (see subdivisions below)

   b. Student Centered
1) Procedures
   a) Tells students how to proceed with work
   b) Shows examples of assignment done and explains it
   c) Nods, answers, or gives assent to student procedures
   d) Refers to materials and the instructions on the use thereof
   e) Gives or shows instructions to individuals, groups, or class
   f) Stops the class work and calls attention to specific procedure
   g) Gives or shows instructions for individual laboratory work
   h) Asks group about their procedures
   i) Tells students how to do work and how not to do it
   j) Gives or shows students the procedures for solving a problem

2) Knowledge
   a) Presents or asks content in chronological order
   b) States facts, gives factual answer or reply or asks factual question
c) Gives explanation of phenomenon, process, or detail

d) Introduces subject

e) Presents problem and gives results as facts

f) Gives answer to question student missed

g) Gives detailed information

h) Gives exceptions to a law and examples thereof

i) Gives vocabulary list

j) Gives symbols and explains meaning thereof or asks meaning of symbols

k) States equality of given terms

l) Refers to text presentation of terms

m) Explains illustration

n) Asks for a term

o) Asks for name of process, structure, etc.

p) Asks for identification of object

q) Asks content question and gives answer

r) Extends factual knowledge from given information

s) Writes, draws, diagrams content on chalk board

t) Listens while student reads
3) **Scientific Process**

a) Asks for prediction of results from a given procedure or situation

b) Asks how certain information could be obtained experimentally

c) Asks for an interpretation or explanation of data

d) Reminds students to keep eyes open

e) Asks student what usually happens under given conditions

f) Asks question about possible ways of getting information in biology

g) Distinguishes hypotheses from facts observed

h) Asks a question a second time but gives different variables

i) Asks: "Can you think of a simpler way?"

j) Asks critical question on scientific method

k) Presents hypothetical situation

l) Reads a question pertaining to the explanation of a result of experimentation

m) Discusses the traits of a scientist

n) Asks how problem was solved

o) Asks: What about that? Could that happen?"
p) Asks sequence of specific questions that forces correct conclusion
q) Asks for the possible results of a problem
r) Asks for elaboration or extension of content from the known
s) Asks: "How do you know?"
t) Asks students what they think about given content, data, statements; asks question requiring judgment, evaluation
u) Asks students to think of exceptions
v) Makes a statement for student evaluation
w) Asks students why they took a particular position
x) Asks a question requiring inference(s) from present or previous information
y) Asks deductive thought question
z) Asks inductive thought question
aa) Extends student question and relates it to lab to follow but does not answer question
bb) Presents problems or problem situations for students to think through
cc) Reads problem statements
dd) Participates in or involves students in gathering, processing, and analyzing
ee) Aids students in making scientifically useful and accurate observations

ff) Aids students in working out problem-solving and experimentation skills

gg) Asks and discusses basis of meaning of terminology

hh) Asks questions requiring value judgments by students

4) Tentativeness of Knowledge

   a) Makes statement emphasizing incompleteness of knowledge in given area of content

   b) Makes statement regarding tentativeness of knowledge or notes tentativeness of scientific knowledge

   c) Makes explanation with phraseology which implies tentativeness of information

5) Generalizations

   a) Reviews content in general terms or asks review questions

   b) Uses generalizations to summarize

   c) Reviews sequence of previous study, classwork, content
d) Refers to organization of the chapter under consideration

e) Explains an entire process as the reverse of another in summary

f) Poses a review problem requiring inferences

g) Summarizes by asking a broad question

h) Asks a mathematical summary question

6) Articulation of Content

a) Cites economic example in illustrating a principle

b) Asks economic question

c) Introduces new topic as pertaining to the use of previous information

d) Relates content of lab work to paperwork already done

e) Relates one area of content in biology to another area of content in biology

f) Calls attention to a previous discussion, previous work, or previous information

g) Asks a background information question

h) Poses problem requiring use of previous information
1) Refers to previous experiences and knowledge of students

j) Relates content to earlier questions or considerations

k) States plans for tomorrow

7) Facilitates Communication

a) Motions to student with hand(s) after asking question

b) Motions to chalk board, overhead projector screen, models, specimens, charts, or other aids

c) Asks student(s) to speak loudly

d) Recognizes student intent to make contribution or ask question (points to student, nods, says "yes," calls student by name, etc.)

e) Writes or records student answer on chalk board or overhead projector

f) Repeats or confirms student statement

g) Asks: "Does that answer your question?"

h) Points out differences in questions asked

i) Repeats, rereads, restates teacher or student question, answer, problem or statement
j) Makes hand motions for emphasis
k) Makes statement emphatically (raises voice, motions with hands)
l) Gives pronunciations of terms
m) Asks for answers to questions
n) Clarifies the framework of a question
o) Articulates sources of communication

6. Affectivity

a. Positive Affectivity

1) Smiles at correct answer
2) Smiles while listening to student contribution
3) Smiles approval at student action
4) Writes honor roll students on board and calls attention to them
5) Nods head in the affirmative
6) Uses hands to draw out responses
7) Pats student
8) Reassures student(s)
9) Thanks student for correction or correct answer
10) Makes obvious use of a kind voice
11) Speaks as if he were very interested in the topic
12) Thanks student for his contribution
13) Points out the value of a student's contribution
14) Gives credit to student concerning his actions
15) Responds in a kind tone of voice to incorrect answer and gives a second chance
16) Recognizes skill of a student in certain areas
17) States or asks (associated non-verbal behaviors are extremely important here):
   a) "That's a boy"
   b) "That's better"
   c) "Go ahead and cut the fish" (encouragement)
   d) "This is pretty easy, isn't it?"
   e) "Nice to work with symbols, isn't it?"
   f) "Fine"
   g) "Good"
   h) "Keep it up...good"
   i) "Very good"

b. Negative Affectivity
1) Admonishes student for not picking up a fish
2) Uses sarcasm to motivate student action
3) Makes a face at an incorrect answer
4) Jokes at the expense of the student(s)

5) Moves hands in a pushing-away-motion when incorrect response is given

6) Identifies student with poor technique

7) Uses a harsh tone of voice when correcting a student's response

8) Raises eyes and shakes head no

9) Ignores student comments and questions

10) Does not recognize student with his hands raised

11) Points out two students who disagree

12) Hits table with hand at incorrect student procedure

13) Gives a sarcastic answer to irrelevant question

14) Reveals skepticism about student(s) knowledge in general

15) Makes a sarcastic statement concerning student's ability, perfection and coordination

16) Frowns at student who has an accident

17) Remains expressionless at student reply

18) Shakes head in the negative and clicks tongue

19) Glares at student who answers incorrectly

20) Avoids eye contact while talking to or with students
21) Shakes head in disgust

22) States or asks (associated non-verbal behaviors are extremely important here):
   a) "That's wrong"
   b) "If you don't know this, you will be in trouble"
   c) "You're doing the wrong assignment"
   d) "That is poor technique"
   e) "You don't need a slide"
   f) "You are just guessing, work on the problem"
   g) "This will probably bore you but..."
   h) "First graders can figure this out"
   i) "NO"
   j) "I don't believe you"
   k) "Either do this or not"
   l) "Whew...finally got that one out" (wiped brow)
   m) "Start over"
   n) "You people aren't labeling properly"
   o) "Who took the equipment?" (accuses students)
   p) "Did you see?...NO, you couldn't"
   q) "Forget it"
   r) "Not yet"
s) "Y..O..U need a piece of paper"

t) "I give up"
BIBLIOGRAPHY


Horn, E. "Distribution of Opportunity for Participation Among the Various Pupils in Classroom Recitations," Columbia University Teachers College Contributions to Education, No. 67 (1914)

Hughes, Marie M. and Associates. "Development of the Means for the Assessment of the Quality of Teaching in Elementary Schools." Salt Lake City: The University of Utah, 1959 (mimeographed).


Newell, John M., Lewis, W. W., and Withall, John. Mental Health-
Teacher Education. Research Project Research Outline.

Openshaw, M. Karl, and Cyphert, Frederick R., in collaboration
with Overly, Norman V., and Smith, Edgar Ray. "The
Development of a Taxonomy for the Classification of Teacher
Classroom Behavior." Columbus, Ohio: The Ohio State
University Research Foundation, 1965 (mimeographed).

Openshaw, M. Karl, Cyphert, Frederick R., and Others. Development of a Taxonomy for the Classification of Teacher
Classroom Behavior. Columbus, Ohio: The Ohio State
University Research Foundation, 1966.

Pankratz, Roger S. "Verbal Interaction Patterns in the Classrooms

Parakh, Jal S. "A Study of Teacher-Pupil Interaction in High School

Parakh, Jal S. "A Study of Teacher-Pupil Interaction in High School
Biology Classes, Part I. The Development of a Category
System." Ithaca, New York: Cornell University (mimeo-
graphed).

Parakh, Jal S. "A Study of Teacher-Pupil Interaction in High School
Biology Classes. Part II. The Description and Analysis of
Teacher-Pupil Interaction." Ithaca, New York: Cornell
University (mimeographed).

Piltz, Albert and Steidle, Walter, editors. Improving Science Educa-
tion: A Look at the Responsibilities of the State Science
Supervisor in the Administration and Implementation of
Title III of NDEA. Strengthening Instruction in Science,
Mathematics, Modern Foreign Languages, and Other
Critical Subjects, and of Changes in the Science Curriculum. A report of a National Conference of Science Supervisors,
Austin, Texas. Washington, D.C.: U. S. Department of


