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Abstract. This paper outlines some of the significant aspects of research in teaching. Three phases can be disinguished in this research. They are the descriptive, the pragmatic and the eclectic-synthetic ones. The descriptive phase is characterized by the development of classroom observation schedules and the provision of sets of concepts permitting teachers and research workers to communicate about procedures. The categorization of behaviors has resulted in more attention being given to them. Hopefully, the vocabulary and concepts generated in the descriptive phase will not only aid in communicating ideas about teaching but will lead to a greater control over the process.

The pragmatic phase, not mutually exclusive of the descriptive or the eclectic-synthetic ones, is characterized by two developments. The first is the examination of associations between classroom behaviors and pupil growth. The second is the application of classroom observation techniques in teacher education programs. Both developments have contributed to an understanding of the teaching process. For example, research on the association between classroom behaviors and outcomes indicates that some behaviors appear to be consistently related to achievement.

The eclectic-synthetic phase is still embryonic, but some progress is being made in synthesizing concepts from various descriptive studies and in the development of theories of teaching. Much remains to be done in this regard and this paper makes a small first-order contribution to synthesis and eclecticism, and expresses the belief that the future, though challenging, looks brighter than ever before.

Teaching is one of the most important phenomena in our society. Certainly the unit comprising the teacher and his students must rank close to the family as one of the key social arrangements of our society. Because teaching is one of the most common processes, most persons have a point of view about its nature and its effectiveness, and a random sample of any audience would provide a variety of definitions of the term.

"Teaching" refers variously to a body of knowledge or doctrine, to a profession or an occupation and to the activities by which someone makes something known to others (Smith, 1960). In educational literature it is used to refer to an art (Highet, 1950), to interpersonal influences and to the acts of a teacher (Connell, 1967; Gage, 1963; 1964; Smith, 1960). In the paper teaching is assumed to refer to a continuing operation or process, and to include a continuous and regular succession of activities not necessarily contiguous. Furthermore, teaching is assumed to involve the dynamic interplay of human personalities in which one individual fosters the development of understanding in another. Understanding involves the learning of skills, ideas and attitudes, and the use of the skills, ideas and attitudes. Stated in another,

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seemingly trite way, teaching is associated with the psychomotor, cognitive and attitudinal development of pupils. This statement, and the ones preceding it, imply and contain one other important feature. Teaching involves the interaction between a learner and other learners, books, teachers, laboratory materials, and the like. Any detailed study of teaching, then, must include an examination of a variety of interactions. But what is known about the nature of the various interactions and their effects on the development of understanding in pupils? What is known about the teaching process?

A great deal has been written about the process, which might imply that much is known. However, much of the writing describes teaching in poetic and metaphorical language, and the variables related to the process may be defined in mystical terms (Corey, 1967). Unfortunately, not a great deal has been established scientifically about the process. In fact, much needs to be learnt about teaching and the variables related to it. This is not meant to imply that the accumulated knowledge among teachers, supervisors and method instructors—the knowledge of ages—is of *no* worth; on the contrary, there is much of value in the body of belief known as pedagogy, or methodology, or practice of the art. There is, too, a great deal of myth, and the myth and the truth are intertwined. One task for the research worker is to tease out the truths from the myths. This difficult task has been approached through increasingly more systematic research during the past two decades. In the last decade the endeavor appears to be characterized by three phases; the descriptive, the pragmatic and the synthetic-eclectic ones.

The purpose of this paper is to examine each of the phases in more detail. The discussion includes references to several research studies, in Iowa and elsewhere, that have made significant contributions to our understanding of the teaching-learning process, and to the development of a theory of science teaching. It is appropriate to note that the three phases referred to are not mutually exclusive, but are convenient categories for classifying research on teaching.

The Descriptive Phase

During the past two decades more research has been concerned with the description and classification of classroom behavior. This interest was an outcome of general dissatisfaction with earlier studies on teaching, especially research on teacher effectiveness. In these studies associations (correlations) were established between teacher characteristics and pupil outcomes. What went on in the classroom was neglected, as if it were inconsequential. Research

workers considered the teacher's age, semester hours of credit and length of teacher education as important independent variables. Several writers pointed out, incisively, that it was imperative to study the "black box", the classroom, and the nature of the interactions in it. It was soon realized that detailed classificatory schemes were needed to describe classroom behavior if the effects of this behavior were to be studied.

Many schemes have been developed. Early classificatory ones included the Withall (1949) scale and the OScAR (Medley and Mitzel, 1963). Later schemes for the classification of verbal behavior included those by Smith and Meux (1962), Smith, Meux, Coombs, Nuthall and Precians (1967), Flanders (1960) and Bellack et al (1966). Those by Flanders and Bellack were also used to study teacher-pupil interaction. This list is not exhaustive. Other classificatory techniques were developed, including those by Gallagher and Aschner (1968), Perkins (1968) and Taba and Elzey (1968).

One limitation of this work was the failure to design a scheme appropriate for the study of teacher-pupil interaction in science classes, especially in laboratory or in inquiry-discovery lessons. This deficiency has been overcome, in part. Recently Parakh (1968) described a category system which provided a reliable description of teacher-pupil interaction in biology classes. Also, Matthews and Phillips (1968) have developed the Science Curriculum Assessment System, which they claim can be used to evaluate innovations in science education, including the extent to which the teaching-learning process in science is discovery-inquiry or lecture oriented. In Colorado, Anderson, Struthers and James (1970) are working on a classificatory system for verbal and non-verbal behavior. They state that their technique is useful for studying elementary and secondary science classes. Two versions of their instrument have been used in studies of science and social studies lessons. With an earlier form of the instrument significant relationships were found between measures obtained in elementary school science classes and student scores on tests of creative and critical thinking.

At present there is a plethora of schemes for classifying classroom behavior and there are reports of more schemes in various developmental stages. Although the interest of research workers in the teaching process may be commendable, it is salutory to realize that little consideration appears to be given to the work of others in the field, resulting in a great conglomeration of concepts for classification. Furthermore, most of the schemes have little, if any, basis in educational and psychological theory. This "theory-less" orientation raises serious questions about the validity and value of behavior categories and correlations between the categories and

pupil growth. This is not to imply that many of the schemes lack a rationale; rather the behavior categories now need to be related more adequately to psychological theory or theories. Nevertheless, the descriptive phase of research in teaching has yielded many benefits. A set of concepts has been provided as well as terms allowing research workers and teachers to communicate more effectively about classroom procedures and directing attention to specific behaviors. Given a vocabulary in terms of which they can understand and talk about teaching, teachers will, hopefully, gain more control over the process.

Studies using classificatory schemes have provided much data about the nature and patterning of discourse in science classes. One study, for example, found that grade 8 science teachers tolerated responses that did not meet the demand of a question, more frequently required pupils to name objects, state or recall facts than to evaluate, predict, classify and infer and were neutral with respect to learner-support or "warmth" (Tisher, 1968). Taba and Elzey (1968) found that when the teacher attempts to raise the level of thought e.g., from naming objects to making inferences, very early in a lesson discussion, this typically results in the pupils returning to a lower and in inability to sustain discussion at higher levels of thought. On the other hand, according to Taba and Elzey (1968, p. 452):

> ". . . a strategy representing an effective pacing of shifting the thought into higher levels seems to follow a characteristic course. The level of seeking information is sustained for a considerable time during the first portion of the discussion. Grouping is requested only after a large amount of information has been accumulated. The result is that in a fairly brief period, children transcend from grouping to labeling and then to providing reasons for labeling and to inferences."

In a recent descriptive study of individualized instruction, Neujahr (1970) [1] found that in sixth grade math, social studies and science lessons, there was a low ratio of substantive (involving subject matter) to instructional (involving assignments, behaviors, etc.) moves. His study also showed that girls made more "moves" (statements) than boys. Girls responded, reacted and structured classroom discourse much more than boys.

The classification of classroom behaviors using more recent schemes for systematic analysis has provided information about the nature and patterning of classroom discourse, non-verbal behaviors and teacher-pupil and pupil-pupil interaction, but there is the need, too, to discover associations between the ecological data and pupil growth. The study of these associations is a part of the pragmatic phase of research.

[1] NEUJAHR, J., 1970. "A Descriptive Study of Individualized Instruction", Minneapolis, Paper presented to the American Educational Research Association annual convention.

The Pragmatic Phase

Science teachers and research workers are interested in the association between pupil growth and teacher behavior, pupil behavior, pupil characteristics and classroom interactions. A survey of many theses and publications in science education at the University of Iowa, for example, supports this contention. The theses and papers deal with such topics as: the effects of guided-discovery and didactic teaching (Thomas, 1968; Thomas and Snider, 1969); the effects of "direct" and "indirect" teacher behavior (Stevenson, 1968); learning outcomes from group and individualized CBA (Krockover, 1970); the effects of demonstration and laboratory methods (Yager, Engen and Snider, 1969); the effects of different teaching styles (Yager, 1966) and the association between prior experience and achievement in college physics (Witten, 1967).

Several factors have contributed to this local research interest and orientation. During the decade, 1958 to 1967, there was no significant change in science teaching methods in Iowa (Crawley, 1967), but administrative policy with respect to patterns of science programs were liberalized, program were broadened and teachers became better prepared (Crawley, 1967; Voss, 1958).

The pragmatic phase of research in teaching is characterized by two developments. The first is the examination of the associations between classroom behaviors (as defined in descriptive studies) and pupil outcomes, (as measured by special tests) and the second is the application of research findings to pre-service teacher education. An ancillary development is the use of classificatory schemes by science supervisors and teachers.

Association between teacher behavior and pupil outcomes. Recently Rosenshine (1969) reviewed the results of 20 studies of teaching behavior related to pupil achievement. However, 20 studies are probably too few to permit conclusions on the influence of teaching behavior outcomes. In only a few cases was there clear indication of an association between teacher behavior and pupil growth, but the review does show that several specific behaviors (e.g., probing, structuring, practice and moderation or variation in questioning) appear to be consistently related to achievement.

Meanwhile, additional, heartening reports are appearing. A well controlled study by Nuthall (1968) used programmed learning materials to study the effects of different teaching strategies on 10th grade pupils' understandings of two sociological concepts. Differences in teaching strategy could be related to differences in student performance on a criterion test. For example, strategies involving "moves" or statements in which examples are noted and discussed were likely to be effective in developing an understanding

of the concepts. Nuthall also attempted to examine the effects of new sequences of behavior—sequences which either did not or only infrequently occurred in classrooms. The findings provide guidelines for effective and less effective teachers; a situation not common in research on teaching. Usually studies imply how less effective teachers can become like the more effective, but not how the effective teachers may become more effective.

Tisher (1968) found an association between teacher behavior and the development of grade 8 understanding in science using a modified Smith and Meux (1962) scheme for the classification of behavior. He used a non-equivalent control group design which was a naturalistic one in the sense that variables were not manipulated. The teachers observed were classified into those who more frequently used higher cognitive procedures and those who less frequently used these procedures. Student growth was observed during one academic year. Some significant and interpretable results were obtained. They included:

1. Teachers low in higher-cognitive procedures have a greater effect on student gains in understanding for pupils with a high rather than low attitude toward science.
2. Gains in understanding are greatest for able pupils when they are taught by teachers who do not rate low in frequency of higher-cognitive procedures.
3. Pupils who prior-knowledge is high show greater gains in understanding when taught by teachers who do not rate low in frequency of higher-cognitive procedures.

Applications to teacher-education programs. The ideas, results and techniques derived from systematic research on teaching are being applied in programs of teacher education. The work of the Stanford school, in this regard, is well-known and well-documented, especially with respect to training effects of feedback and modelling procedures (McDonald and Allen, 1967) and micro-teaching (Allen and Ryan, 1969). Other colleges have imitated Stanford, but have added special features to their work, including the use of video-recording techniques, and simulation.

In the Appalachia Educational Laboratory, West Virginia, Kennedy, Haefele and Ruff (1970)[2] studied the effectiveness of two interaction analysis instructional modules within an inservice setting. The project involved 90 teachers who used the VICS, a modified Flanders scheme (Amidon and Hough, 1967) of interaction analysis to code classroom behavior. Although there was no statistical significant change in classroom behavior, participants did acquire a knowledge of interaction analysis. Hopefully, this knowledge sensitized them to the multiplicity of classroom interactions

[2] KENNEDY, J., HAEFELE, D. & RUFF, R., 1970. "The Effectiveness of Interaction Analysis Instruction within an Inservice Setting", Minneapolis, Paper presented to the American Educational Research Association annual convention.

and gave them a vocabulary of terms to communicate more effectively with each other.

The belief that an understanding of the techniques of interaction analysis confers benefits on teachers has stimulated the use of these procedures in pre-service programs at the University of Iowa and the University of Queensland, Brisbane, Australia. At Iowa City, after initial orientation to a modified Flanders scheme, students use it to analyze behaviors in classrooms of demonstrating teachers and in their own classrooms during practice teaching sessions. In Brisbane, trainee teachers use a modified Bellack scheme (Bellack et al, 1963) to study video-recordings of their own behaviors during practice teaching. Some evidence that trainee teachers do benefit from experiences with interaction analysis and of changes in classroom behaviors was achieved (Amidon and Hough, 1967). However, much research is still required on effects of interaction analysis experiences.

Classificatory schemes can also be used to stimulate discussion during in-service programs. In Iowa, recently, science supervisors have been trying out a simple, eclectic system (Tisher, 1970)[3] for analyzing classroom behaviors, making use of the ideas of Bellack et al (1963), Flanders (1960), Smith and Meux (1962) and Withall (1949).

The Eclectic-Synthetic Phase

Renewed and revitalized interest in the teaching-learning process is encouraging, though little practical benefit has yet accrued. More studies and practical applications are needed. There is a need to try out the classificatory techniques in more teacher-education programs. There is an urgent need to synthesize concepts from classroom studies and to relate behavior categories to educational and psychological theories. Furthermore, there is a need to be eclectic. Attempts to utilize concepts from varied schemes may yield valuable eclectic models for the study of classroom behavior. Synthesis and eclecticism might lead to the development of theories of science teaching.

The following remarks are intended as a first order contribution to the task of developing theory and of fostering synthesis and eclecticism in research on teaching, and are characteristic of the burgeoning eclectic-synthetic phase.

It is generally accepted that the teaching-learning process is multi-dimensional, but the process can be described and studied

[3] TISHER, R., 1970. "A Preliminary Schedule of the Analysis of Classroom Behavior Designed for Science Supervisors and Science Teachers", Science Education Center, University of Iowa, Iowa City. Paper presented to Science Supervisors. (mimeo)

in terms of three important dimensions (pedagogical, socio-emotional and control). The pedagogical dimension deals with what a teacher or pupil does with books, materials or the words he speaks. The socio-emotional dimension deals with "classroom climate" and includes the notion of learner-supportiveness. The control dimension deals with whether pupil or teacher guides learning activities and the nature of the power and authority exercised by pupils and teachers. While these dimensions cannot here be described in greater detail or defined operationally, it is appropriate to state that many behaviors can be subsumed under these dimensions—behaviors associated with pupil outcomes. For example, structuring discourse, evaluating responses and asking higher-cognitive questions (Tisher, 1968) are associated with cognitive growth in pupils and may be subsumed under the pedagogical dimension.

Using the three dimensions, classrooms may be described by locating them in a "teaching space." Classrooms might be plotted by where they rank on pedagogical, social-emotional and control measures, assuming that all dimensions must be considered and are indicative of differences in pupil growth. Research may provide details for more concise specification of relationships between "positions in the teaching space" and pupil outcomes, out of which implications for science teaching may come.

These somewhat cursory, incompleted ideas are presented to characterize the emerging ecectic-synthetic phase of research in teaching. They highlight the need for a more concerted effort to synthesize concepts from classroom behavior studies and psychological theory. The future is challenging, but it also looks brighter than ever before.

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