EFFECTS OF MODULARIZED SCIENCE INSTRUCTION ON STUDENT ACHIEVEMENT AND ATTITUDES IN INNER CITY JUNIOR HIGH SCHOOLS

A Dissertation

Presented to

the Faculty of the College of Education

University of Houston

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Education

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by

James L. Connor

August 1972

TO MY WIFE

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ABSTRACT

This study was designed to investigate the effects of the presentation of eighth grade science material in modular form. The factors investigated were the effect of modularized instruction on (1) students' attitudes toward school, science class, scientists, and science, (2) student achievement of subject matter mastery in eighth grade science, and (3) the retention of the subject matter. The basis for comparison was a control group taught by the teachers' usual methods.

The various experiences of the students, other than instructional mode, were held as constant as was feasible. This included the use of common behavioral objectives, laboratory activities, use of audiovisual materials, field experiences, and other potential or probable sources of variability. In short, the only difference between the experimental treatment and the treatment of the control group was assumed to be the use of modules for the experimental group and nonmodularized instruction for the control group.

In order to measure changes in student attitudes a semantic differential scale, developed by the investigator was administered to 198 students as a pre- and posttest. After factor analysis of the results of the pretest, four composite adjective pairs were formed on the basis of the clustering of certain adjective pairs. These composite adjective pairs were used in an analysis of variance design in which the dimensions were treatment (experimental/control), school (four campuses), and observation (pre-/posttest), and variable (composite adjective pairs).

The test for cognitive gain and retention was constructed by the investigator using the behavioral objectives of the modules as a source for item development. The KR20 reliability coefficient of this instrument (which was used for both gain and retention) was 0.915. Inter-item correlation was 0.134.

No significant differences attributable to the use of a modular format for instruction were found for either attitude change, cognitive gain, or cognitive retention. However, it was found that the factor analysis of the semantic differential data indicated a consistent association of Activity with Evaluation. This is in variance with Osgood's original Evaluation (Factor I), Activity (Factor II), and

Potency (Factor III). Some other studies have also found this Evaluation-Activity factor among adolescent subjects.

In summary, it would appear, from studies of individualized instruction coupled with the inferences drawn from analysis of the semantic differential data, that active involvement of the student in his own learning may contribute more to the success of his school experience than any other factor.

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CHAPTER I

INTRODUCTION

Among the many problems facing the large metropolitan school district is the poor pupil performance in the so-called "inner city" school. The term "inner city" school is, in its general connotation, used to characterize schools located in areas of low income, substandard living conditions, and generally having a high proportion of people of ethnic minorities.

Many students of these schools are generally apathetic and often hostile toward the school. Thus, as these students reach adolescence with its own peculiar problems added to the aforementioned attitudes, their school experiences are often unpleasant and unproductive. It would seem that the opportunity for peer group contact and the compulsory attendance laws are the major factors that keep many of these students, if not most, in school.

From discussion in the literature (e.g., Stone and Schneider, 1971), it appears that some sort of structured learning may be necessary for the inner city child since his non-school environment is relatively unstructured. This type of learning, particularly when coupled with frequent reinforcement, may be effective for socialization processes as well as for cognitive and psychomotor learning.

Along with structure learnings, individual student differences must be recognized by the teacher and dealt with. Many prevailing teaching methods have provided structure but have tended to ignore, to a large degree, individual differences among students. This has placed the learner in a passive position in which he assumes little responsibility for his learning. Furthermore, these methods have conditioned many children to accept failure as inevitable consequence of going to school.

The need for individualized instruction has been recognized for years. The nineteen-sixties saw several thrusts in the direction of individualized instruction. "Teaching machines", computer-assisted instruction, and programmed texts came to the forefront, the last being the most often used because of their relative economy. The development of behavioral objectives, basic to all three modes of instruction, represents an important step toward individualized instruction inasmuch as they allow the specification of competencies which the individual can demonstrate. The use of behavioral objectives, self-paced learning, and concommitant provisions for learning styles of pupils have generated instructional approaches which can be individualized to a high degree. The organization of material and learning experiences in this way is a principal constituent of what has come to be called modularized instruction.

An instructional module is a set of materials, both hard- and software, containing all the necessary elements for the facilitation of reaching specific learning objectives. Its scope is relatively narrow and specific. While styles of modules may vary somewhat, the basic ingredients are (1) explicitly stated behavioral objectives, (2) a pretest, (3) a group of learning activities designed to achieve the skills specified as behavioral objectives, and (4) a posttest.

The behavioral objectives specify, in terms of observable outcomes, what capabilities the learner should possess on completion of the module.

The pretest measures the extent to which the learner already possesses the capabilities stated in the objectives of the module. If the learner is able to demonstrate mastery of the objectives it is not necessary that he complete the module.

The learning activities of a module provide instructional sources for the student. Usually alternate activities are included to accommodate individual learning styles and to provide choices for the learner. All of the activities are geared specifically toward obtainment of the capabilities specified by the objectives.

The posttest is used to determine whether the learner has successfully completed the module; that is, whether he possesses the capabilities specified by the behavioral objectives. If the learner "fails" the posttest he recycles through the module, perhaps selecting an alternate set of learning activities, to remedy his deficiencies and then takes another posttest.

The degree to which individualization of instruction is obtained in a modular approach varies. It may involve simply modularization of the material within an existing syllabus and the development of activities around existing tests or laboratory experiences. A more highly developed form of modularization would included the development of individualized learning packets as well as the modification of faculty skills. The basic format of modular use is essentially the same regardless of the degree of development.

The Problem

The trend toward the use of teaching modules has received much attention in the last few years and is continuing to gain impetus. The development of modules and the use of comptency-based instructional methods have a high priority in the Teacher Corps program within which this study was carried out.

In this study, the focus was upon a question important to the development and implementation of a modular approach to teaching science in inner city junior high schools. The question raised is: if the same general conditions, resources, and materials are presented to different groups of similar students, does the placing of the material in a modular format:

(1) significantly affect students' attitudes toward school, science class, scientists, or science?

(2) significantly affect students' mastery of the subject matter?

(3) significantly affect students' retention of the subject matter?

Importance of the Study

The efficacy of the use of modularized instruction in the inner city junior high school is an area of study which appears to have received little attention. As was suggested in the Introduction, poor pupil performance is a problem in inner city schools. Part of the problem may be related to students' attitudes toward school, the relevancy of subject matter, and the values which the school supports.

It is important to ascertain whether the use of modularized instruction is, in itself, a useful approach in helping the inner city child to increase cognitive achievement and to develop certain positive attitudes toward learning. If this format for instruction is more effective than more conventional methods, it would be advantageous to continue its development.

If, on the other hand, no significant differences are observed, the apparent effects of modularized instruction may be attributed to other factors which may be independent of the instructional design, or, at least, not generalizable to all situations. If no significant effect can be attributed to modularization alone, then it would appear that schools should avoid the conversion of a curriculum to modular format without consideration of the other components associated with individualized instruction.

CHAPTER II

REVIEW OF RELATED LITERATURE

Individualized Instruction

There is general agreement among educators that individualized instruction is desirable. It is also evident that the educational system, in its present form, is not geared to the needs of the individual. The tutorial method of the distant past could accommodate the privileged few, but the rise of mass education is, by definition, anti-individual.

The development of the concept of, and schemes for, programmed instruction opened the door to a practical solution to the problem of individualizing instruction. The teaching machine, developed by Pressey in the nineteen-twenties, was originally designed to facilitate the taking and scoring of objective tests. The machine was found to have the ability to teach; while it did not become popular, studies showed it to be effective as a teaching device (Hilgard and Bower, 1966).

B. F. Skinner has applied the principles of operant conditioning to automatic self-instruction (e.g., Skinner, 1954, 1958). Through the use of "shaping", which is the selective reinforcement of certain simple behavior, the learner acquires a pattern of complex behavior, composed of the behaviors which were reinforced.

In terms of human learning, selective reinforcement of the acquisition of a series of relatively simple and easily acquired skills leads to the mastery of a relatively complex task. As individual learners would vary in the rate in which their behavior is "shaped", one might infer that individualization of learning is implicit.

Similar to Skinner's scheme in which the learner moves step-wise through a set of material (generally referred to as <u>linear programming</u>), another type of programming called <u>branching programming</u> has also been developed. In this model, which is usually associated with Crowder, the reader of a programmed text is directed to various inputs according to his response to a multiple choice question (Hilgard and Bower, 1966). Both types of programming have been improved, adapted, and commercialized. They have also been adapted for computer-assisted instruction. However, the programmed textbook, due to its relatively low cost, has had much greater application than either teaching machines or computer assisted instruction.

The next development which impinged on the subject of individualized instruction is that of behavioral objectives. Again, the primary focus here is not individualization of instruction but, rather, the definition of learner objectives in terms of observable learner behavior (Mager, 1962). The development of clearly defined objectives expressed in such terms, while not an entirely new idea, was probably first applied to educational programs by Tyler in the early nineteen-thirties (Ebel, 1970). However, behavioral objectives gained their real impetus in the early part of the nineteen-sixties as a result of the work of Mager and others (Gagné, 1970).

That the notion of the use of behavioral objectives could be relevant to the individualization of instruction is suggested indirectly by Mager.

> . . . the student is provided the means to evaluate his own progress and is able to organize his effort into relevant activities. (Mager, 1962, p. 4)

A number of projects involving individualized instruction have been reported. Among these perhaps the best known is the IPI (Individually Prescribed Instruction) program initiated at the Oak Leaf School in Pittsburgh. This project involves the diagnosing of individual student needs and the writing of "prescriptions" to fit particular students (Education USA, Special Report, 1968). This elementary school program, by the fall of 1970, was serving seventy-five thousand students in two hundred and sixty four schools.

In the field of junior high school science the Intermediate Science Curriculum Study (ISCS) program places heavy emphasis on individual progress and self-paced learning (Burkman, et al., 1968).

Kline (1971) reports a project for individualizing junior high school Earth Science instruction in which the teaching units consist of blocks of interrelated material. The student works through a block at his own pace with the necessary instructional resources being made available to him as part of the block. When the student completes a block he selects another block and proceeds in the same fashion. Kline found that the students using the blocks did as well on a test of subject matter mastery but expressed greater satisfaction than the conventionally taught students.

A similar arrangement involving BSCS biology is reported by Fulton (1971). Student-teacher "contracts" were used in tenth grade biology class. When a student finished a contract he could progress to another. Fulton found that the "contract" group did significantly better than a comparison group on the BSCS Comprehensive Examination, the Test on Understanding Science, Watson-Glaser Critical Thinking Assessment, and Prous Subject Preference Survey. Nor were significant differences found on the Nelson Biology Test or the Silance Attitude Scale. The comparison group was made up of students taught under conventional group instruction.

Other high school science programs incorporating individualized instruction in some form have been reported (e.g., McCurdy and Fisher, 1971; Richard, 1969; Krockover,

1971) and in college Earth Science (Bybee, 1969) and the interest in individualization of teaching in science seems to be continuing. An operational model for individualizing science instruction has been proposed by Altieri, Gadsen, and Allen (1971). This model consists of a linear mainstream of activities with branches representing skill areas (remediation and enrichment).

Workers in the area of mathematics education have also shown interest in individualized instruction. The editors of The Arithmetic Teacher put out a call for descriptions of projects involving individualized instruction in mathematics in August, 1970. In the March, 1971 issue of the journal they began listing projects, of which there was a large number (The Arithmetic Teacher, 1971).

McQueen (1971) reviewed a number of other projects not discussed here. She observed that they all have in common, progress at a self-determined pace, and often self-selected subjects and self-satisfying goals, the "self" referring to the student.

Mizel (1970), in a review of the trend toward individualization of instruction reaches conclusions similar to those of McQueen. Although he was concerned with higher education, the concepts which he puts forth are generalizable to all levels of education. He cites five characacteristics of individualized instruction. These are:

> . . . a self-determined pace that is comfortable for him [the student]. . . work at times that are convenient to him . . . begin instruction at a point appropriate to his past achievement . . . learners are inhibited by a small number of easily identifiable skills or knowledges . . . furnishing the learner with a wealth of instructional media from which to choose . . . (Mitzel, 1970, p. 435)

Modularized Instruction

In the discussion of individualized instruction, it is fairly evident that all of the individualized instruction models discussed fit closely the description of modularized instruction as defined in Chapter I. The individual "folders" for each child in IPI (Education USA:Special Report, 1968), the "blocks" of interrelated material used in the Earth Science project reported by Kline (1971) and the "contracts" in the BSCS Biology project reported by Fulton (1971) all strikingly resemble what are now called modules. This same characteristic is exhibited in an integrated chemistry-physics program in which a core of thirty-three "packets" with forty-seven "branch packets" is used (McCurdy and Fisher, 1971). The same general factor appears in other programs or models reviewed (Richard, 1969; Krockover, 1971; Altieri, *et al.*, 1971).

A major development for "self-pacing" and in effect, modularization is embodied in the UNIPAC project. This project, under aegis of the Institute for the Development of

Educational Activities, collects, disseminates, houses, and evaluates curricular materials in the form of learning packages (UNIPACS). The emphasis in the UNIPAC concept is on five ingredients. These are concepts, behavioral objectives, multi-dimensional learning materials, and activities, pre-, self- and post-evaluation, and quest (development of self-initiative and self direction) (Kapfer and Swenson, 1968).

It would appear that modularized instruction, no matter what name it goes under, is becoming fairly widespread. However, most modular schemes include certain resources and conditions not generally obtainable in the inner city school, such as adequate equipment and facilities including provisions for activity centered learning. Therefore, the apparent success of these programs does not provide any substantive information about the effects of modularized material used under the constraints of limited resources, inflexible scheduling, a relatively fixed curriculum as well as teachers who are not extensively trained for working with modularized material and individualized instruction.

The Inner City School

There is little doubt that the inner city school is a problem area in education. The factors contributing to this problem area have been discussed by numerous writers and researchers. For example, Owens and Steinhoff (1969) review the failure of traditional school strategies in the inner city schools. Many other such as Kohl (1967) and Postman and Weingartner (1970) have pointed out, sometimes quite angrily, the failure of the schools.

A number of strategies for improving the inner city school have been proposed, most of which involve removing such obstacles as teacher racism (e.g., Smith, 1969), the lack of open communication (Owens and Steinhoff, 1969), and irrelevancy of the curriculum (e.g., Postman and Weingartner, 1970).

One suggestion germaine to this study was made by Havighurst, although it referred to programmed instruction rather than modularized instruction.

> Programmed learning is an example, where it is used skillfully. The pupil accepts an assignment to learn a particular lesson or set of facts, and he is informed immediately of every successful step he takes toward this goal.
>
> According to this view, the pupil must accept the notion that he has hard work to do which will require effort on his part in order to achieve the goal that he sees clearly. (Havighurst, 1970, p. 373)

This is not to say that the factors discussed by the other authors cited above are not important, but rather that this study does not attempt to deal with any factors other than the instructional format and its effect.

Attitude

The term "attitude" has been defined in a number of ways. Thomas and Znaniecki (1918) considered an attitude to be an internalized counterpart of an external object and which represented the individual's subjective tendencies to act toward that object.

Allport (1935) regarded attitude as being a mental and neural state of readiness to respond. To Allport, attitudes are organized through experience and exert a directive or dynamic influence on behavior.

McGuire (1971) suggested an operational definition for attitude.

> Typically, the person's attitude regarding an object is operationally defined as the response by which he indicates where he assigns the object of judgement along a dimension of variability. The dimension of variability is usually an evaluative one like desirability, but may occasionally be another such as probability of occurrence. (McGuire, 1971, p. 8)

Osgood also proposed an implicitly similar definition based on the concept of semantic space.

> It seems reasonable to identify attitude, as it is ordinarly (sic) conceived in both lay and scientific language, with the evaluative dimension of the total semantic space, as this is isolated in the factorization of meaningful judgments. (Osgood, Suci, and Tannenbaum, 1957, p. 190)

Stern (1963) stated that most definitions of attitude agree on four fundamental points.

> 1. Attitudes are socially formed. They are based on cultural experience and training and are revealed in cultural products. The study of life history data reveals the state of mind of the individual, and of the social group from which he derives, concerning the values of the society in which he lives.
>
> 2. Attitudes are orientations toward others and toward objects. They incorporate the meaning of a physical event as an object of potential or actual activity.
>
> 3. Attitudes are selective. They provide a basis for discriminating between alternative courses of action and introduce consistency of response in social situations of an otherwise diverse nature.
>
> 4. Attitudes reflect a disposition to an activity, not a verbalization. They are organizations of incipient activities, of actions not necessarily completed, and represent therefore the underlying dispositional or motivational urge. (Stern, 1963, p. 404)

Science-related Attitudes of Students

A number of studies have examined student attitudes toward science or science-related subjects. Among these studies was one which investigated the use of current events in ninth grade science class as a means of influencing student attitude toward science. The investigator administered pre- and posttest (not described in the article) to matched groups over a period of half a school year. The group using the current event approach scored significantly higher than the control (Kahn, 1962).

Another study of attitude change investigated the effect of fifth grade children experiencing a particular unit of new science material. The children were classed by three levels of socioeconomic status and by treatment. The experimental treatment was the ESSP Animal Coloration unit. Significant differences in attitudes were detected using a projective type test devised by the investigator. The test consisted of three interwoven projective techniques — word association, thematic apperception, and sentence completion. The pretests indicated significant differences according to socioeconomic level. The posttest showed significant attitudinal shifts, particularly among low socioeconomic groups (Lowery, 1966).

Studies involving individualized instruction in which attitude and attitude change have been considered have indicated that students showed significantly more positive attitudes, either in receptivity or interest toward the course and expressed a preference for the individualized mode of instruction (Bybee, 1969; Fulton, 1971; Kline, 1971; Krockover, 1971). Fulton's study, however showed a significant difference between individualized group and the comparison group on the Prous Subject Preference Survey but no significant difference on the Silance Attitude Scale.

It might be mentioned that most of these studies were conducted with high school or college students (with the exception of Kline's study). It is also important to note that none of the individualized instruction projects involved inner city schools and were also generally free of many of the constraints encountered in the schools in which this study was carried out.

The results obtained in the above mentioned studies did indicate effects on attitudes. It is generally agreed that attitudinal change is a valid goal of teaching. For this reason much of this study is devoted to that aspect.

The Use of the Semantic Differential Technique

A major focus of this study was the development of a suitable measurement of the attitudinal change which might result from modularized instruction. As this was a major part of this study, a high priority was assigned to the development of a suitable instrument. While a detailed account of the evolution of the attitude scale constructed for this study will be given in Chapter III, the rationale for selecting the semantic differential technique will be discussed here.

The semantic differential technique was developed during the early and middle nineteen-fifties by Osgood, Suci, and Tannenbaum. Their primary interest was in the problems of "meaning". At the time of their beginning work (and currently, to a large extent), "meaning" was an elusive thing more akin to "idea" or "soul" than to observable stimulus-response type phenomena. Thus "meaning" had been, to a large degree, considered a philosophical rather than a psychological problem.

The significance of "meaning" has not been denied by social scientists as Osgood points out.

> Most social scientists would agree — talking freely on common-sense grounds — that how a person behaves in a situation depends upon what that situation means or signifies to him. And most would also agree that one of the most important factors in social activity is meaning and change in meaning — whether it be termed "attitude", or "value", or something else again. (Osgood, et al., 1957, p. 1)

The problem of measuring meaning gave rise to a hypothetical model from which a measurement technique could be developed. The development of this model is described by Osgood, et al.

> We begin by postulating a semantic space, a region of some unknown dimensionality and Euclidian in character. Each semantic scale, defined by a pair of polar (opposite-in-meaning) adjectives is assumed to represent a straight line function that passes through the origin of this space, and a sample of such scales then represents multidimensional space . . . . To define the semantic space with maximum efficiency, we would need to determine that minimum number of orthogonal dimensions or axes (again, assuming the space to be Euclidian) which exhaust the dimensionality of the space — in practice, we shall be satisfied with as many such independent dimensions as we can identify and measure reliably. The logical tool to uncover these dimensions is factor analysis . . . (Osgood, et al., 1957, p. 25)

A detailed description of the development of such an instrument is discussed in detail by Osgood, Suci, and Tannenbaum (1957). In essence, though, the instrument in its final form consisted of pairing a concept with a set of bipolar adjectives. The direction and intensity of the association (response) was indicated on a seven-step scale.

A large majority of studies which employed the semantic differential technique consistently showed the factors Evaluation, Activity, and Potency as a pervasive common set of dimensions (e.g., Osgood, et al., 1957; Snider and Osgood, 1969). The most significant factors in terms of variance accounted for was Evaluation.

Returning to Osgood's (1957) definition of attitude in which he stated that attitude could reasonably be identified within the evaluative dimension of semantic space, the logic of semantic differentiation as a means of measuring attitude was justified. Further, the inclusion of other semantic factors (e.g., Activity and Potency) may provide insight into the individual person's perception of the concept. This would perhaps be more predictive of the way in which a person would act toward the concept (Osgood, et al., 1957).

It also appeared that a semantic differential instrument might examine attitudes in a more subtle way than conventional rating scales based on requested introspection. The need for a subtle, indirect approach arose from the suspicion that some of the students might avoid negative responses, for fear of teacher retaliation. This use of a number of adjective pairs which were not obviously evaluative in nature would, it was felt, tend to minimize this potential source of invalidity.

Another problem associated with the sample was the relative lack of verbal fluency on the part of the subjects. This seriously limited the use of any technique involving requested introspection. This situation is described by Osgood, *et al.*, 1957).

> For highly intelligent and verbally fluent subjects this method [requested introspection] would be sufficiently sensitive, since it seems likely that a language will tend to include those discriminations which its users find necessary to communicate. Less fluent subjects, however, find it very difficult to encode meanings spontaneously . . . (Osgood, *et al.*, 1957, p. 19)

In order to use linguistic encoding, a combination of controlled associations and a scaling procedure which presents both direction and intensity of association was needed. The semantic differential provided this in the form of a seven-step scale between bipolar adjectives (Osgood, *et al.*, 1957).

Since the late nineteen-fifties, the original developers, as well as numerous other workers, have demonstrated to a high degree the usefulness and validity of the semantic differential technique. A fairly comprehensive review of experimental work with the technique is presented by Snider and Osgood (1969). Since the later nineteen-sixties the measurement of specific school-related attitudes, through the use of the semantic differential technique, has gained momentum.

The application of the technique to school-related attitudes has led to some results which are incongruous with the earlier studies of the connotations of a wide range of concepts. Osgood and his coworkers, using various concepts, seemed to establish an Evaluation, Activity, Potency structure both within and across cultures (Osgood, et al., 1957). It also would appear that this factor structure held up in children as young as third graders (DiVesta, 1966; DiVesta and Dick, 1966). However, some studies of school-related attitudes do not show the "traditional" Evaluation, Activity, Potency factor structure in a clear-cut manner.

For example, Husek and Wittrock (1962), using ratings of school teachers on eighty scales obtained from 259 college students who planned to become teachers, observed that a large factor (39% of common variance) of general Evaluation emerged. Included within this factor were the Evaluation, Activity, and Potency dimensions.

Yamamoto and his coworkers, working with four hundred suburban junior high students from the seventh and ninth grades, and using two clusters of concepts — "people" and "curriculum", obtained similar results. In the "people" cluster nearly forty percent of the total common variance loaded on Evaluative and Potency scales, a second factor (12% of common variance) loaded on Activity with some Potency and

Evaluation. The investigators named these factors Merit and Movement, respectively. The first factor for the "curriculum" cluster of concepts accounted for forty-three percent of the total common variance. It loaded on such scales as <u>strong</u>, <u>large</u>, <u>fast</u>, <u>alive</u>, <u>interesting</u>, <u>helpful</u> and <u>good</u>, thus including all three of the traditional "Osgoodian" factors. This factor they named Vigor (Yamamoto, Thomas and Wiersma, 1969).

A subsequent study examined how differentially the concepts "people" and "curriculum" were perceived on the factors of Merit, Movement, Security, Vigor, and Certainty, as a function of pupil grade and sex. The investigators used factor scores in the study of school-related perceptions (Yamamoto, Thomas, and Karns, 1969).

A more recent study of school-related perceptions of Negro, Mexican-American, and American Indian children also used factor scores for Merit, Movement, Security, Vigor, and Certainty (Thomas and Yamamoto, 1971). The last two studies were of children from the sixth, seventh, and eighth grades.

The emergence of, as it were, hybrid factors in contrast to Osgood's Evaluation, Activity, and Potency factors seems to indicate that the linguistic perceptions of early adolescents may differ from those of adults and, possibly, those of younger children.

The evidence put forth by DiVesta (1966), which was discussed earlier in this section, is corroborated by Neale and Proshek (1967), who studied school-related attitudes of fourth, fifth, and sixth grade children. Their sample included 142 low socioeconomic status subjects and 208 high socioeconomic status subjects. They found that Evaluation emerged as the first factor followed by Activity, then Potency. However, less than ten percent of the total variance was accounted by either the second or third factor. The Evaluation factor was heavily loaded for both high socioeconomic status and low socioeconomic status children, the latter group showing a heavier loading. It is notable that, in Neale and Proshek's study, slow-fast loaded heavily (.390 for high socioeconomic group and .327 for the low socioeconomic group) on Factor I for both groups and excited-calm loaded heavily (.506) on Factor I for the low socioeconomic group.

The results of Husek and Wittrock's study, Yamamoto and his coworkers' studies and, to some degree, those of Neale and Proshek's study suggest that factors other than Evaluation, Activity, and Potency may be more useful for the assessment of school-related attitudes.

SUMMARY

There is currently much interest in individualizing instruction. This interest is manifested at all levels of formal education — from elementary through higher education. In many cases the involvement in individualized instruction is on a modest scale, generally experimental in nature, and usually rather limited in scope. A few programs for individualizing instruction were found to be quite extensive and involved large numbers of students.

Most of these programs, whether large or small, were built around a format similar to, if not identical to, that described for modularized instruction.

A number of authors have discussed the nature of attitudes. Out of these discussions have come various operational definitions of the term "attitude". It was agreed that an individual's attitude toward an entity might be predictive of the way in which the individual would act toward it. The individual's attitude apparently is representative of his evaluation of the entity. While it might be predictive of how he would act toward it, his total perception of the entity would be a <u>better</u> predictor of his tendency to act toward it.

The use of a semantic differential technique was found to be a potentially efficacious method for measuring

attitude — particularly the "tendency to act" dimension because semantic differentiation includes factors other than evaluation.

No study of the effects of modularized instruction in inner city junior high school science was found. Neither was any study found which specifically examined the effects of modularization of material only; that is, where the resources for learning activities were not included in the total "package".

CHAPTER III

PROCEDURE

The General Design of the Study

This study was designed to investigate the effects of the presentation of eighth grade science material in modular form. The factors investigated were the effect of modularized instruction on (1) students' attitudes toward school, science class, scientists, and science, (2) student achievement of subject matter mastery in eighth grade science, and (3) the retention of the subject matter. The basis for comparison was a control group taught by the teachers' usual methods.

The period of the experiment was from January 24, 1972 to March 24, 1972 which comprised the third (of four) nine week grading period of the Houston (Texas) Independent School District. This experimental period was desirable in that the students had time to develop attitudes toward science over the first semester of their first year of junior high school science course work. It also avoided the administrative problems typically associated with the ending of the school year.

The Sample

One hundred and ninty-eight eighth grade students from four junior high schools were involved in the study. One teacher from each of the four participating schools selected two of his or her classes which were similar in size, academic performance, and discipline characteristics. None of the classes were homogeneously grouped. Each teacher presented material in modular form to one of these two classes. Thus, four classes, each from a different school, formed the experimental group and four classes, each from a different school formed the control group. At the time of the pretesting, the experimental group contained 102 subjects and the control group, 96 subjects.

Controlling Sources of Variability

As each teacher instructed both the experimental and the control classes in a particular school, the teacher effect should have been similar for each group. No differences were noticeable for class size, number of males and females, ethnic makeup, and the teacher's perception of the two classes he or she selected for use in the study.

The various experiences of the students, other than instructional mode, were held as constant as was feasible. This included the use of common behavioral objectives, laboratory activities, use of audiovisual materials, field experiences, and other potential or probable sources of variability. In short, the only difference between the experimental treatment and the treatment of the control group was assumed to be the use of modules for the experimental group and nonmodularized instruction for the control group. See Appendix H for Teacher's Guide and modular format used in this study.

Measurements

Two general parameters were examined in this study. One of these, the effect of the treatment on the students' attitudes toward school, science class, scientist, and science, entailed the use of pre- and posttest measurements. A semantic differential instrument was constructed for this measurement.

The second parameter which this study measured was cognitive gain and medium-term (three weeks) retention of concepts and information. The achievement test used was developed directly from the behavioral objectives of the nine week period of the experiment. Approximately three weeks after the first administration, the achievement test was readministered as a measure of medium-term retention of the gains made during the experiment.

All assessment instruments were administered by the teachers.

Instrument Development

The Attitude Scale

The decision to employ the semantic differential technique for the measurement of attitudinal changes was made on the basis of its apparent efficacy and convenience relative to other methods of attitude measurement. The rationale for this decision was discussed in Chapter II.

Construction of the Prototype Semantic Differential

A semantic differential scale consisting of twelve adjective pairs was developed. Four pairs were presumed to represent the Evaluation dimension, four, the Activity, and four, the Potency dimension. They were selected on the basis of their loadings on the Evaluation, Activity, and Potency dimension in studies reported in the literature (Snider and Osgood, 1969).

The scale was administered to a group of 28 eighth grade students in a science class not included in the study. It was found that some explanation and clarification of the printed instruction sheet was required. A count of the number of neutral responses was made for each adjective pair. The adjective pairs and frequencies of neutral responses are shown in Table 1. The complete instrument appears in Appendix A.

TABLE 1

ADJECTIVE PAIRS AND FREQUENCIES OF NEUTRAL RESPONSES[1]
FOR PROTOTYPE[2] OF SEMANTIC DIFFERENTIAL
N=28

ADJECTIVE PAIRS	FREQUENCY OF NEUTRAL RESPONSE
BAD-GOOD	26
SLOW-FAST	21
UNPLEASANT-PLEASANT	26
INACTIVE-ACTIVE	15
COLD-WARM	34[3]
SOFT-HARD	31[3]
DEAD-ALIVE	16
FAR-NEAR	41[3]
WEAK-STRONG	23
WORTHLESS-VALUABLE	26
SAD-HAPPY	23
LOOSE-TIGHT	43[3]
MEAN OF FREQUENCIES	27
MEDIAN FREQUENCY	26

1 The use of "4" on a seven point scale (1-7)

2 The concepts in this form were "school", "teachers", "science teachers", "science class", "scientist", and "science" (See Appendix A).

3 Deleted in second form

The mean frequency of neutral responses was found to be 27.1. The median frequency was 26.

Four adjective pairs were found to have frequencies of neutral responses in excess of any of the central tendency values. While no test for significance was made, the investigator elected to delete these adjective pairs on the basis of their high frequencies of neutral responses.

Selection of Adjectives for a Revised Scale

As a result of the difficulty with the prototype scale, it was concluded that a different approach to adjective pairs selection should be taken. Based on the inference that some of the adjective pairs might not have been within many of the subjects' vocabularies, a list of adjectives was compiled. Nineteen of the adjectives were selected from The Dale List of 769 Easy Words (Lorge, 1959). Six more adjectives were selected because of their reported high loadings on either the Evaluation, Activity, and Potency factors (Snider and Osgood, 1969).

The list of 25 adjectives comprised the basis of an instrument which required the listing of "opposites" of each of the adjectives. The instrument was administered to 26 eighth grade students not involved in the study. The administration took place in English classes at two of the schools involved in the study. The list of the 25 adjectives and the frequencies of occurrence of the most often cited "opposites" appears in Table 2. The complete antonym instrument may be found in Appendix B.

Construction of the Revised Semantic Differential

A revised semantic differential scale was assembled. The selection of the adjective pairs for this revised form was made on the basis of the data obtained from the analysis of the original scale (see Table 1) and the responses to the list of 25 adjectives (see Table 2). It was observed that, while adjectives _active_, _valuable_, and _pleasant_ received relatively few responses on the adjective list, they received below-average frequencies of neutral responses. _Active_, for which _quiet_ was the most often cited antonym (three out of 36 responses) received the lowest number of neutral responses on the semantic differential test when paired with _inactive_ (fifteen "4's", or neutral responses). It was thus paired with _inactive_, rather than _quiet_ in the revised semantic differential.

Worthless was the most often cited antonym of _valuable_. It was used nine times. _Unpleasant_ was cited most often as the "opposite" of _pleasant_, its frequency of occurrence being eight times.

Valuable-worthless and _pleasant-unpleasant_ each received 26 neutral responses on the semantic differential.

TABLE 2

TWENTY FIVE ADJECTIVES*, THEIR MOST FREQUENTLY PERCEIVED ANTONYMS, AND THE FREQUENCY OF THE USE OF THE ANTONYMS

N=36

ADJECTIVE	ANTONYM	FREQUENCY
FAST	SLOW	36
ACTIVE	QUIET	3
HOT	COLD	36
SHARP	DULL	29
ALIVE	DEAD	35
STRONG	WEAK	35
HEAVY	LIGHT	34
THICK	THIN	33
LARGE	SMALL	34
CLEAN	DIRTY	35
VALUABLE	WORTHLESS	9
KIND	MEAN	24
PLEASANT	UNPLEASANT	8
HAPPY	SAD	34
NICE	MEAN	20
FAIR	UNFAIR	6
FRESH	STALE	11
BEAUTIFUL	UGLY	31
SWEET	SOUR	29
HARD	SOFT	32
LOUD	QUIET	19
BRAVE	SCARED	19
ROUGH	SMOOTH	18
WIDE	NARROW	15
DEEP	SHALLOW	16

* See Appendix B

This was the same frequency as the frequency of neutral responses for the adjective pair good-bad.

It was inferred that active-inactive, valuable-worthless, and pleasant-unpleasant when presented in a polar context became meaningful; whereas, when presented as single adjectives to a subject whose vocabulary was limited, the subject could not generate an appropriate antonym. On the basis of this reasoning the adjective pairs, active-inactive, valuable-worthless, and pleasant-unpleasant were concluded to be useful adjective pairs. The other adjective pairs used had low frequencies of neutral responses on the original semantic differential or high frequencies of responses on the list of 25 adjectives. The set of adjective pairs appears in Table 3. The polarity was reversed in a random fashion to discourage response set.

This scale, with a revised set of instructions, was administered to 34 eighth grade science students. Only the concepts "science class", "scientist", and "science" were included. This revised scale may be found in Appendix C.

Analysis of the responses to this scale was one of testing the internal consistency for each of the factors, Evaluation, Activity, and Potency for each concept, "science class", "scientist", and "science". That is, nine analyses were made, each involving factor by concept dimensions. The factors were made up of sets of four adjective pairs. Each

TABLE 3

RELIABILITY COEFFICIENTS[1] FOR FACTORS FOR

REVISED FORM OF SEMANTIC DIFFERENTIAL

N=34

FACTOR	ADJECTIVE PAIRS	CONCEPT		
		SCIENCE CLASS	SCIENTIST	SCIENCE
EVALUATION	BAD-GOOD UNPLEASANT-PLEASANT WORTHLESS-VALUABLE HAPPY-SAD	0.73	0.63	0.83
ACTIVITY	SMALL-LARGE SLOW-FAST DEAD-ALIVE INACTIVE-ACTIVE	0.65	0.75	0.67
POTENCY	SMALL-LARGE WEAK-STRONG LIGHT-HEAVY THIN-THICK	0.45	0.52	0.55

1 Kuder-Richardson Formula 20 for scaled responses (Ferguson, 1965)

set contained pairs which normally would be expected to load on the designated factors.

The test for internal consistency which was used was a modified form of the Kuder-Richardson Formula 20 (Ferguson, 1965). Estimated reliabilities ranged from 0.83 for the Evaluation of "science" to 0.45 for Potency of "science class (see Table 3).

The Research Semantic Differential Scale

The instrument which was constructed for pre- and posttesting included the instructions and adjective pairs from the previously constructed instrument. However, the concepts "music" and "school" were inserted ahead of "science class", "scientist", and "science". This scale was then administered to 198 subjects comprising the experimental and control groups (see Appendix D).

Factor analysis of the data yielded 16 factors. These factors were rotated by the Varimax method and significant variable-factor correlations were identified (see Appendix E).

Eight of the factors appeared to be concept-specific. It was also observed that Potency seemed to separate into two factors. One seemed to be negative or oppression form of potency and the other, a positive or efficacy form. The efficacy form appeared concept-specific although not limited to the concept present; it appeared to include other concepts not presented. The oppression form of Potency seemed to be a single factor, however.

On the basis of these observations, tentative names were given to each of the 16 factors. Factors I through V all appeared to be hybrids of Evaluation and Activity with some Potency. Each of the five factors were similar but appeared to be uniquely related to specific concepts. Factor I was named Vigor of Science Class, Factor II, Vigor of School, Factor III, Vigor of the Scientist, and Factor IV, Vigor of Music, and Factor V, Vigor of Science. These factors strongly resembled Yamamoto's Vigor factor (Yamamoto, Thomas, and Wiersma, 1969), thus the name Vigor was employed.

Factor VI appeared to be a potency factor. However, the concepts "school", "science class", "scientist", and "science" and the adjective pairs light-heavy, thin-thick, and fast-slow loaded heavily on the factor. It was named Oppressiveness.

Factor VII was, like I through V, a hybrid. It was interpreted to be indicative of Acceptance of Middle Class Values; that is, a positive attitude toward all of the concepts presented.

Factor VIII was identified as a potency factor, but the only significant loadings involved "science class", "scientist", and "science". It was named Efficacy of Science.

Factor IX, was similar to VIII but mainly involved the concept "scientist". It was named Efficacy of the Scientist.

Factor X contained mostly what would usually be considered potency, and evaluation adjective pairs. All concepts were represented, but "music" showed a negative correlation for the worthless-valuable scale. This factor was named Efficacy of Knowledge.

Factor XI included all five concepts and appeared to be a General Potency factor.

Factor XII contained activity and potency with some evaluation. "Science class", "science", "school", and "music" were encompassed by this factor suggesting that it was possibly a general factor. The heavy loading of slow-fast suggested the possibility that this adjective pair might have connoted stupid-smart. This factor was named Academic Achievement.

Factor XIII seemed to be antithetical to Factor X with the potency of music loading most heavily on it. It was therefor named Efficacy of Talent.

Factor XIV, included all concepts except Scientist. There were positive correlations for activity and evaluation of "music" but negative correlations for potency of "school", "science class", and "science". This suggested the name Sensory for this factor.

Factor XV seemed to be a general potency factor, all five concepts were represented. It, like XI was named General Potency.

Factor XVI was largely an activity factor and included "scientist", "science", "science class", and "school". It was speculated that this might be a Laboratory Enthusiast factor.

Development of Composite Variables

On the basis of the tendency of groups of variables to load heavily on certain factors, four composite variables were formed from the means of the responses to the component variables (see Table 4). The first of these was composed of the adjective pair *slow-fast* for all of the five concepts. It was called *diffuse-intense*.

The second composite variable was composed of the adjective pairs *light-heavy* and *thick-thin* for all of the five concepts. It was called *supportive-oppressive*.

The third composite variable was formed from the adjective pairs *good-bad*, *dull-sharp*, *unpleasant-pleasant*, *worthless-valuable*, *dead-alive*, *inactive-active*, and *sad-happy* for all concepts. The hybrid named *baddead-goodlive* was assigned to this variable.

The fourth composite variable, called *impotent-dynamic*, was formed from the adjective pairs *small-large* and *weak-strong* over all five of the concepts.

TABLE 4

COMPOSITION OF COMPOSITE VARIABLES

Composite Variable[1]	Component Variables[2]
1 DIFFUSE-INTENSE	SLOW-FAST
2 SUPPORTIVE-OPPRESSIVE[3]	LIGHT-HEAVY
	THICK-THIN
3 BADDEAD-GOODLIVE	GOOD-BAD
	DULL-SHARP
	UNPLEASANT-PLEASANT
	WORTHLESS-VALUABLE
	INACTIVE-ACTIVE
	SAD-HAPPY
4 IMPOTENT-DYNAMIC	SMALL-LARGE
	WEAK-STRONG

[1] Numbers 61, 62, 63, and 64 in 64 variable instrument

[2] Each adjective pair for every concept; e.g., diffuse-intense included variables 4, 16, 28, 40, and 52 (slow-fast for "music", "school", "science class", "scientist", and "science", *et cetera*.

[3] Subsequently reflected to oppressive-supportive to maintain the same polarities for use in the analysis of the data.

A subroutine was then inserted into the computer program which would generate subject's ratings for each of the four composite variables. Factor analysis with Varimax factor rotation was again carried out, but the factoring terminated with the extraction of twelve factors. The twelve factors were, due to their loadings, assigned names different from those names used in the sixty variable analysis.

Factor Analysis of the Sixty-four Variable Semantic Differential

Composite Variable 61, called diffuse-intense loaded heavily (-0.807) on Factor VI of the sixty-four variable factor analysis, which was named Action.

Composite Variable 62, called supportive-oppressive loaded heavily (-0.740) on Factor II, of the sixty-four variable factor analysis, which was named Supportiveness.

Composite Variable 63, baddead-goodlive, loaded mainly on Factor I (Vigor of the School), Factor IV (Beneficence of the Scientist), and Factor V (Vigor of the Science Class). The Factor loadings were 0.474, 0.493, and 0.505, respectively.

Composite Variable 64, impotent-dynamic loaded heavily on Factor IX (Efficacy of Science). The highest loading in this case was -0.704. It was concluded that the four variables, diffuse-intense, supportive-oppressiveness, baddead-goodlive, and impotent-dynamic could be used as a basis for analyzing the attitudinal dimension of the study. At the same time, the polarity of the adjective pair supportive-oppressive was reversed to become oppressive-supportive so that all four adjective pairs had the same polarity, thus a particular response would yield the same numerical value for any variable. See Appendix F for the factor loadings in the 64 variable factor analysis.

The Construction of the Research Instrument

A computer program was written which generated scores for each subject on each of the four composite variables for each of the five concepts "music", "school", "science class", "scientist", and "science". The effect of this procedure was the formation of a twenty item pretest; that is, four composite adjective pairs for each of the five concepts.

The twenty variable semantic differential test was factored and rotated. Six factors were extracted as a result of this analysis. The factor loadings are shown in Table 5.

The first factor, as in previous factor analyses exhibited a definite communality among evaluation, activity, and potency. No adjective pairs applying to the concepts "music" and "school" had significant loadings on Factor I. The highest loadings were "scientist": diffuse-intense (0.75), "scientist": baddead-goodlive (0.68), "scientist": impotent-dynamic (0.55), "science": baddead-goodlive (0.49), and

TABLE 5

ROTATED FACTOR ANALYSIS OF 20 COMPOSITE VARIABLE

SEMANTIC DIFFERENTIAL INSTRUMENT[1]

(decimal points omitted)

Factor I - Vigor of the Scientist

Variable	Concept	Adjective Pair	Factor Loading
13	scientist	diffuse-intense	75
15	scientist	baddead-goodlive	68
16	scientist	impotent-dynamic	55
19	science	baddead-goodlive	49
17	science	diffuse-intense	49
20	science	impotent-dynamic	27
10	science class	supportive-oppressive	-24
11	science class	baddead-goodlive	22
14	scientist	supportive-oppressive	-18

Factor II - Remoteness of Science or Scholarship

Variable	Concept	Adjective Pair	Factor Loading
18	science	supportive-oppressive	71
10	science class	supportive-oppressive	69
14	scientist	supportive-oppressive	68
6	school	supportive-oppressive	66
16	scientist	impotent-dynamic	38
20	science	impotent-dynamic	34
11	science class	baddead-goodlive	-31
12	science class	impotent-dynamic	28
17	science	diffuse-intense	-28
19	science	baddead-goodlive	-24
8	school	impotent-dynamic	21

Factor III - Triviality of Music

Variable	Concept	Adjective Pair	Factor Loading
1	music	diffuse-intense	-80
4	music	impotent-dynamic	-50
5	school	diffuse-intense	-32

Factor IV - Vigor of Science Class

Variable	Concept	Adjective Pair	Factor Loading
9	science class	diffuse-intense	80
12	science class	impotent-dynamic	60
17	science	diffuse-intense	49
11	science class	baddead-goodlive	34
20	science	impotent-dynamic	25
19	science	baddead-goodlive	22
5	school	diffuse-intense	20

TABLE 5 CONTINUED

Factor V - Dullness

Variable	Concept	Adjective Pair	Factor Loading
7	school	baddead-goodlive	-85
8	school	impotent-dynamic	-67
10	science class	supportive-oppressive	-62
19	science	baddead-goodlive	-61
5	school	diffuse-intense	-54
15	scientist	baddead-goodlive	-49
3	music	baddead-goodlive	-37
16	scientist	impotent-dynamic	-25
17	science	diffuse-intense	-20
20	science	impotent-dynamic	-20
12	science class	impotent-dynamic	-20
		Factor VI - Sensory	
2	music	supportive-oppressive	-68
4	music	impotent-dynamic	-60
20	science	impotent-dynamic	-60
12	science class	impotent-dynamic	-38
3	music	baddead-goodlive	-37
5	school	diffuse-intense	37
16	scientist	impotent-dynamic	-25
18	science	supportive-oppressive	-25

[1] Adjective pair supportive-oppressive subsequently reflected to obtain same polarity as other adjective pairs for analysis of data.

"science": diffuse-intense (0.49). The factor loadings suggested the name Vigor of the Scientist.

Factor II included all of the concepts except Music. The maximal loadings on this factor were "science": oppressive-supportive (-0.71), "science class": oppressive-supportive (-0.69), "scientist": oppressive-supportive (-0.68), and "school": oppressive-supportive (-0.66). This factor at first appeared to be an oppressiveness factor. However, when viewed in relation to Factor I, it was inferred that Factor II might connote remoteness. It was thus tentatively assigned the name Remoteness of Science or Scholarship.

Factor III was rather cryptic with only three variables having significant loadings on it — "music": diffuse-intense (-0.80), "music": impotent-dynamic (-0.50), and "school": diffuse-intense (-0.32). Reflection of the pairs would indicate that "music" and "school" were more diffuse than intense and "music" was more impotent than potent. It was named Triviality of Music.

The fourth factor extracted seemed to be a Science Class factor. "Science class": diffuse-intense (0.80), "science class": impotent-dynamic (0.60), "science": diffuse-intense (0.49), and "science class": baddead-goodlive (0.34) were the variables most significantly correlated with Factor IV. This factor was named Vigor of Science Class.

Factor V appeared to represent negativism toward all five concepts. Eleven variables loaded significantly on this factor and all but one of them showed negative correlations. There was a gradation ranging from -0.85 to -0.20 with no distinct cut off point. The most significant were "school": goodlive-baddead (-0.85), "school": dynamic-impotent (-0.67). The factor loading of "science class": oppressive-supportive is positive. Thus it would appear that, while Factor V appears to represent negative aspects of every concept, science class is more supportive than oppressive, with a correlation of 0.62. Because of the generally negative tone Factor V was named Dullness.

Factor VI continued loadings for all of the concepts except "school", which appeared as more intense than diffuse (0.37). There is, however, the possibility that intensity, in this factor, may connote stress rather than activity, when it it viewed in relation to Factor VI. "Music": oppressive-supportive (0.68), "music": impotent-dynamic (-0.60), and "science": impotent-dynamic (-0.60) were the variables most significantly correlated with Factor VI. The total makeup of this factor suggested the tentative name Sensory (see Table 5).

It was found that a comparison of the factor analysis of the sixty variable semantic differential test with the twenty composite-variable test exhibited similar patterns in spite of the extraction of sixteen factors in the former and six factors in the latter. The formation of the composite variables greatly simplified the factor structure with, it appeared, only a relatively small loss of information.

The sixty variable (twelve adjective pair for each of the five concepts) semantic differential test was readministered during the week when the students were in the fourteenth or fifteenth module. This was approximately nine weeks after the pretest. Thus the twenty composite variable instrument was used as a pretest and posttest for the comparison of attitudinal changes in the experiment and the control group.

The Achievement Test

The other focus of this study was cognitive gain and the retention of this gain; that is, the learning and retention of information presented during the period of the experiment.

As was indicated previously, the behavioral objectives, syllabi, and specific learning activities were applied to both the experimental and the control groups. The difference was the method or format for presentation of the course during a nine week period.

A 75 item multiple choice test (four choices) was constructed. The method for item development entailed devising multiple choice questions which would determine whether or not the various behavioral objectives were met. In many cases, posttest items from modules were converted to a multiple choice form. In other cases items were developed which were more indirect.

The achievement test; that is, the test for the measurement of cognitive gain, was administered by 189 control and experimental students.

The reliability coefficient of the instrument was 0.915 (by the Kuder-Richardson Formula 20). The interitem correlation was 0.137 and the mean of item difficulty was 0.524. The test mean and standard deviation were 39.30 and 13.20, respectively.

The generally favorable statistical characteristics of the test coupled with its relatively high rational or content validity (due to its development directly from the behavioral objectives) suggested that it would be an acceptable instrument for the measurement of specific cognitive gains which obtained from the nine weeks of instruction which comprised the period of the experiment.

The test for the retention of cognitive gains involved the same instrument described in the previous paragraphs. It was administered approximately three weeks after the administration of the achievement test; the instrument can be found in Appendix G.

Statistical Design

A two by two by four by four analysis of variance with repeated measures on two dimensions was used to analyze the semantic differential data. The four dimensions were OBSERVATION (two: pretest-posttest), TREATMENT (two: experimental-control), CLASS (four: schools), and VARIABLE (four: composite adjective pairs). The repeated measures were in the OBSERVATION and VARIABLE dimensions. This analysis was done separately for each of the five concepts — "music", "school", "science class", "scientist", and "science". In order to removed the effect of heterogeneity of variance among the four variables, the raw scores were transformed to standard scores; that is, the scores were transformed in such a way that each variable had a mean of 4.0 and a standard deviation of 1.5. Thirteen scores were randomly selected from each class, with the exception of one class which had only 13 subjects in which the pre- and posttest had been completed. In this class all scores were used.

The statistical design for the compairson of achievement test scores was also an analysis of variance design. It was a four by two factorial design with four CLASS factors (schools) and two TREATMENT factors (experimental and control). Thirteen subjects made up each cell as in the attitudinal test analysis.

The same design was employed in the analysis of retention test scores except that 12 subjects were used in each cell. This reduction in cell size was due to the failure to obtain retention test scores on some subjects who had been included in the sample used for analyzing the achievement test scores.

In all of the analyses, an alpha level of .05 or less was set for a requirement of significance.

CHAPTER IV

FINDINGS

In this study, the focus was upon a question important to the development and implementation of a modular approach to teaching science in inner city junior high schools. The question raised was: if the same general conditions, resources, and materials are presented to different groups of similar students, does the placing of the material in a modular format (1) significantly affect students' attitudes toward school, science class, scientists, or science; (2) significantly affect students' mastery of the subject matter; (3) significantly affect students' retention of the subject matter?

To answer this question, three hypotheses were tested.

HYPOTHESIS$_1$ The use of a modular format for science instruction does not effect a significant change in the attitudes of eighth grade inner city students' toward (1) school, (2) science class, (3) scientists, or (4) science.

This hypothesis was tested by comparing pre- and posttest semantic differential transformed responses, standardized to a mean of 4.0 and standard deviation of 1.5, to each of the composite adjective pairs*: diffuse-intense, oppressive-supportive, baddead-goodlive, and impotent-dynamic for five concepts. The five concepts were "music", "school", "science class", "scientist", and "science". The first concept, "music" was included as a neutral stimulus for establishing the stability of the semantic differential instrument. If significant trends for the concepts other than "music" were detected, the concept "music" (presumably unaffected by the experimental treatment) could be analyzed for similar trends.

Subjects' responses to the adjective pairs were also compared on the basis of treatment; that is, experimental (modularized format) and control (nonmodularized format), and the school from which each sample was drawn.

A two treatment (experimental and control) by four class (school) by two observation (pre- and posttest) by four variable (composite adjective pairs) analysis of variance, with repeated measures on the two latter dimensions, was designed and applied to each of the five concepts. To remove the possibility of overall mean differences and heterogeneity of variance between adjective pairs, the scores were standardized in such a way as to give each composite adjective

*The composite adjective pairs were generated through factor analysis of the original adjective pairs included in the semantic differential instrument. See pp. 37-40.

pair a mean of four and standard deviation of one and one half (see p. 46).

No significant differences attributable to treatment were detected. There was also no significant interaction found between treatment and observations for any of the concepts. Tables 6, 7, 8, 9, and 10 provide summaries of analyses of variance.

On this basis, $Hypothesis_1$ could not be rejected. Thus it appeared that a modularized format used for a nine week period in science instruction did not effect a significant change in the attitudes of eighth grade inner city students toward (1) school, (2) science class, (3) scientist, or (4) science.

$HYPOTHESIS_2$ The use of a modular format for science instruction does not significantly affect the degree of mastery of subject matter (cognitive gain) by eighth grade inner city students.

A four class (school) by two treatment (experimental and control) analysis of variance was used to process the data. No significant effect which was attributable to treatment was detected. Thus $Hypothesis_2$ could not be rejected. Therefore it also appeared that the use of a modular format for science instruction for nine weeks did not significantly affect the degree of mastery of subject matter (cognitive gain) by eighth grade inner city students. See Table 11 for

TABLE 6

SUMMARY TABLE FOR ANALYSIS OF VARIANCE FOR THE CONCEPT MUSIC

SOURCE	DF	MS	F
TOTAL	831		
BETWEEN SUBJECTS	103		
TREATMENT (modular and nonmodular)	1	.156	.046
SCHOOL (4 campuses)	3	2.929	.856
TRMNT x SCHL	3	2.429	.710
$ERROR_B$	96	3.420	
WITHIN SUBJECTS	728		
OBSERVATION (pretest and posttest)	1	5.618	2.932*
TRMNT x OBSERV	1	.000	.000
SCHOOL x OBSERV	3	4.126	2.153
TRMNT x SCHL x OBSERV	3	2.637	1.376
$ERROR_{W1}$	96	1.916	
VARIABLE (4 composite adjective pairs)	3	.000†	
TRMNT x VAR	3	9.347	3.365*
SCHL x VAR	9	5.687	2.047*
TRMNT x SCHL x VAR	9	2.902	1.045
$ERROR_{W2}$	288	2.778	
OBSERV x VAR	3	.552	.428
TRMNT x OBSERV x VAR	3	.376	.291
SCHL x OBSERV x VAR	9	2.412	1.871
TRMNT x SCHL x OBSERV x VAR	9	1.813	1.406
$ERROR_{W3}$	288	1.289	

† Variance removed in rescaling variable before analysis.
* Significant at .05 level.

TABLE 7

SUMMARY TABLE FOR ANALYSIS OF VARIANCE FOR THE CONCEPT SCHOOL

SOURCE	DF	MS	F
TOTAL	831		
BETWEEN SUBJECTS	103		
TREATMENT (modular and nonmodular)	1	4.611	.835
SCHOOL (4 campuses)	3	1.847	.334
TRMNT x SCHL	3	2.729	.494
$ERROR_B$	96	5.523	
WITHIN SUBJECTS	728		
OBSERVATIONS (pretest and posttest)	1	.025	.012
TRMNT x OBSERV	1	.978	.491
SCHOOL x OBSERV	3	4.297	2.156
TRMNT x SCHL x OBSERV	3	4.541	2.282
$ERROR_{W1}$	96	1.993	
VARIABLE (4 composite adjective pairs)	3	.000✝	
TRMNT x VAR	3	.815	.399
SCHL x VAR	9	4.136	2.025*
TRMNT x SCHL x VAR	9	5.983	2.929**
$ERROR_{W2}$	288	2.043	
OBSERV x VAR	3	.322	.230
TRMNT x OBSERV x VAR	3	.150	.107
SCHL x OBSERV x VAR	9	.976	.697
TRMNT x SCHL x OBSERV x VAR	9	1.038	.742
$ERROR_{W3}$	288	1.400	

✝ Variance removed in rescaling variable before analysis.
* Significant at .05 level.
** Significant at .01 level.

TABLE 8

SUMMARY TABLE FOR ANALYSIS OF VARIANCE FOR THE CONCEPT SCIENCE CLASS

SOURCE	DF	MS	F
TOTAL	831		
BETWEEN SUBJECTS	103		
TREATMENT (modular and nonmodular)	1	2.643	.479
SCHOOL (4 campuses)	3	4.806	.871
TRMNT x SCHL	3	4.822	.873
$ERROR_B$	96	5.521	
WITHIN SUBJECTS	728		
OBSERVATIONS (pretest and posttest)	1	.283	.131
TRMNT x OBSERV	1	.017	.008
SCHOOL x OBSERV	3	2.657	1.233
TRMNT x SCHL x OBSERV	3	1.659	.770
$ERROR_{W1}$	96	2.154	
VARIABLE (4 composite adjective pairs)	3	.000†	
TRMNT x VAR	3	5.696	2.637
SCHL x VAR	9	2.678	1.240
TRMNT x SCHL x VAR	9	4.152	1.922*
$ERROR_{W2}$	288	2.160	
OBSERV x VAR	3	.544	.420
TRMNT x OBSERV x VAR	3	1.335	1.031
SCHL x OBSERV x VAR	9	.469	.362
TRMNT x SCHL x OBSERV x VAR	9	.783	.605
$ERROR_{W3}$	288	1.295	

† Variance removed in rescaling variable before analysis.
* Significant at .05 level.

TABLE 9

SUMMARY TABLE FOR ANALYSIS OF VARIANCE FOR THE CONCEPT SCIENTIST

SOURCE	DF	MS	F
TOTAL	831		
BETWEEN SUBJECTS	103		
TREATMENT (modular and nonmodular)	1	6.545	1.816
SCHOOL (4 campuses)	3	14.038	3.895
TRMNT x SCHL	3	6.766	1.877
$ERROR_B$	96	3.604	
WITHIN SUBJECTS	728		
OBSERVATIONS (pretest and posttest)	1	21.330	11.724**
TRMNT x OBSERV	1	.303	.167
SCHOOL x OBSERV	3	1.603	.881
TRMNT x SCHL x OBSERV	3	3.498	1.923
$ERROR_{W1}$	96	1.819	
VARIABLE (4 composite adjective pairs)	3	.000†	
TRMNT x VAR	3	3.026	1.324
SCHL x VAR	9	3.330	1.457
TRMNT x SCHL x VAR	9	2.017	.883
$ERROR_{W2}$	288	2.285	
OBSERV x VAR	3	.315	.184
TRMNT x OBSERV x VAR	3	2.790	1.636
SCHL x OBSERV x VAR	9	1.402	.822
TRMNT x SCHL x OBSERV x VAR	9	1.867	1.094
$ERROR_{W3}$	288	1.706	

† Variance removed in rescaling variable before analysis.
** Significant at .01 level.

TABLE 10

SUMMARY TABLE FOR ANALYSIS OF VARIANCE FOR THE CONCEPT SCIENCE

SOURCE	DF	MS	F
TOTAL	831		
BETWEEN SUBJECTS	103		
TREATMENT (modular and nonmodular)	1	.374	.069
SCHOOL (4 campuses)	3	4.023	.745
TRMNT x SCHL	3	4.865	.901
$ERROR_B$	96	5.401	
WITHIN SUBJECTS	728		
OBSERVATIONS (pretest and posttest)	1	.031	.018
TRMNT x OBSERV	1	.004	.002
SCHOOL x OBSERV	3	1.684	.985
TRMNT x SCHL x OBSERV	3	.909	.532
$ERROR_{W1}$	96	1.710	
VARIABLE (4 composite adjective pairs)	3	.000✝	
TRMNT x VAR	3	4.420	1.871
SCHL x VAR	9	3.563	1.509
TRMNT x SCHL x VAR	9	2.068	.876
$ERROR_{W2}$	288	2.362	
OBSERV x VAR	3	1.677	1.310
TRMNT x OBSERV x VAR	3	1.819	1.420
SCHL x OBSERV x VAR	9	.777	.607
TRMNT x SCHL x OBSERV x VAR	9	2.687	2.098*
$ERROR_{W3}$	288	1.281	

✝ Variance removed in rescaling variables before analysis.
* Significant at .05 level.

the summary table for the analysis of variance of the achievement test.

HYPOTHESIS$_3$ The use of a modular format for science instruction does not significantly affect the medium term (three weeks) retention of subject matter (cognitive retention) by eighth grade inner city students.

The same analysis of variance design was used to test Hypothesis$_3$ as was used to test Hypothesis$_2$. Similar results were obtained; that is, there was no significant effect detected which could be attributable to treatment. Hypothesis$_3$ therefore could not be rejected. Thus it also appeared that the use of a modular format for science instruction for nine weeks did not significantly affect the degree of medium term retention of subject matter by eighth grade inner city students. See Table 12 for the summary table for the analysis of variance of the retention test.

OTHER FINDINGS

The only significant attitudinal changes detected between observations (pretest and posttest) were for "music" ($p < .05$) and "scientist" ($p < .01$). Comparison of means showed net declines of the students' assessments of these concepts regardless of treatment or school.

There were several higher order interactions which yielded significant ($p < .05$) F-ratios. However, a posteriori contrasts of means, using Duncan's Test, show that the means

TABLE 11

SUMMARY TABLE FOR ANALYSIS OF VARIANCE FOR THE ACHIEVEMENT TEST

SOURCE	DF	MS	F
TOTAL	103		
TREATMENT (modular and nonmodular)	1	5.000	0.035
SCHOOL (4 campuses)	3	852.000	6.049**
TRMNT x SCHOOL	3	351.000	2.492
ERROR	96	140.860	

** Significant at .01 level — one school mean was significantly lower than two other school means.

TABLE 12

SUMMARY TABLE FOR ANALYSIS OF VARIANCE OF RETENTION TEST

SOURCE	DF	MS	F
TOTAL	98		
TREATMENT (modular and nonmodular)	1	61.76	0.41
SCHOOL (4 campuses)	3	2016.43	13.49**
SCHL x TRMNT	3	28.87	0.19
ERROR	88	149.47	

** significant at .01 level — one school mean was significantly lower than two other school means.

that were significantly different were artifactual to this study. That is to say, the significant differences involved means of pretest of an experimental group and the posttest means of a control group within a school on a particular variable, a difference between the experimental group means of one school and the control group means of another school, or some other uninterpretable contrasts.

The analysis of achievement test scores showed a significant class effect; however, no significant treatment by class interaction was detected. _A posteriori_ contrasts showed one of the school means to be significantly lower than two other school means but no other significant differences between means were detected. Duncan's Test was also used for the contrasts of achievement test means.

The analysis of the retention test data revealed the same pattern observed in the analysis of the achievement test data; that is, a significant class effect but no significant treatment by class interaction was found. Contrasts of means indicated that one school mean was significantly lower than the two highest school means.

A t-test for the difference between correlated means showed a significant difference between the achievement test mean (40.08) and the retention test mean (37.58).

In addition to the findings relevant to the tested hypotheses one additional finding should be noted. In the factoring of a semantic differential, most other studies have found that Factor I has been normally an Evaluation factor (see Osgood, et al., 1957). However, in this study the factor analysis showed that for the developed semantic differential, Evaluation, Activity and, to a lesser extent, Potency, loaded together on Factor I of each analysis. This pattern persisted through the factor analysis of the sixty variable form, the sixty-four variable form (sixty administered variables plus four composite variables [see Appendix F] and the four composite variable for [Table 5]). There were, in fact, few factors judged to be primarily evaluative which did not contain some high loadings for activity. The complete results of the factor analyses appeared in Chapter III, but the Evaluative-Activity factor was an important finding of this study, albeit unrelated to the testing of the hypotheses.

DISCUSSION

Interpretation of the Findings

On the basis of the findings of this study, it appears that the efficacy of science instruction, either from the standpoint of student attitude or student achievement was not increased through the modularization of instruction.

Perhaps the general success of individualized instruction over more conventional forms of instruction which has led to widespread enthusiasm in the educational community may be due to factors other than modularization. Included among these factors might be the resources, including both hardware and software, used in modularized instructional programs. These resources, coupled with special training of teachers and "ready-made" syllabi, including behavioral objectives, might lead to more effective teaching. In this study, the "ready-made" syllabi and learning experiences were essentially the same for both the experimental and control groups. Also, each of four teachers taught both experimental and control science class. Thus, the modularization of teaching material was presumably the only difference between science instruction in the experimental and control classes. It might, therefore, be inferred that provision of carefully chosen learning activities is effective whether or not instructional material are modularized.

Possible Sources of Error

Although there is no evidence to indicate that the findings of this study may have been invalid, several sources of error are at least possible.

First, while the semantic differential technique may, in fact, be a valid device for assessing attitude, the <u>par-</u>

ticular instrument designed for and used in this study may have possessed low validity. While the reliability of the instrument was reasonably high, as inferred from communalities (h^2) of the variables and the stability over time (F-ratios for Observations), there was no feasible way within the limitations of this study to test its validity. However, the factor structure was generally congruent with that of other studies involving the same age group.

Second, while the technique of semantic differentiation as a means of measuring attitude appears to have considerable merit, it might not have been appropriate for the population which was sampled in this study. The reported validity of the technique is largely based on correlation of semantic differential responses with responses to other attitudinal instruments (see Osgood, et al., 1957).

The statistical characteristics of the achievement test (for cognitive gain) along with its probably high logical validity (the items were based on specific behavioral objectives) tended to suggest that it was an appropriate measuring instrument.

Another possible contingency was that the modules were of insufficient quality to produce an effect or were not used in such a way as to obtain maximum benefit from them. However, student achievement of the behavioral objectives in both experimental and control groups as reflected in posttesting, exceeded teacher expectation (the control group was taught using the module syllabus, also) and, as such, suggest a relatively high validity of the modules.

Another possible source of error was a carry-over effect resulting from the teachers' working with both experimental and control groups. This effect was minimized by providing only enough modular material for the experimental group, but the teachers may have become more conscious of individualization.

Finally there was the possibility of sampling errors. The teachers selected the classes which participated, there was nothing found which indicated that the sampling was faulty. There were differences among the classes but these differences did not cause a significant difference between the means of the experimental and control groups.

INTERPRETATION OF SEMANTIC DIFFERENTIAL FACTOR ANALYSIS

The analyses of the semantic differential data was characterized by the consistent emergence of an evaluative-activity factor as the first factor (Factor I). This, along with the mixing of the evaluative and activity dimensions in other factors strongly suggests that activity is quite likely a form of evaluation for the age and ethnic group sampled (see Table 5 and Appendix E and F). This phenomenon may have been more a peculiarity of the age group (early adolescense) rather than ethnicity. If so, the results of this study corroborate other studies in which suburban Caucasian subjects of approximately the same age range were sampled (Yamamoto, Thomas, and Karns, 1969; Yamamoto, Thomas, and Wiersma, 1969) and in a study of early adolescents of several ethnic groups (Thomas and Yamamoto, 1971), as well as young adults (Husek and Wittrock, 1962).

If this apparent inseparability of evaluation and activity is typical of the junior high school age group, as it appears to be, it carries serious implications for the structuring of junior high school instruction. It would seem that there is a great need for an activity centered curriculum; that is, one in which the student's role is that of an active participant in his learning experiences. The activity centered curriculum is not a particularly new concept, but is one which has not had much effect on junior high school teaching.

The factor analyses (see Table 5 and Appendix E and F) of the semantic differential suggested some other inferences relative to the students' perception of science and scientist. One of these inferences is that science is perceived as a potent force with almost magical power. It would appear, though, that this power is generally benevolent. This same perception seems to apply to the scientist. Stereotyping of the scientist is also quite evident.

At the same time, science and scientists appear to be very remote. It was inferred that, while these concepts were acknowledged and recognized, it was very difficult for many of the students to relate to them personally. Thus, it would seem that science and scientists represent a powerful but remote entity which may fall more into the supernatural frame of reference than into the students' sense of the real.

These perceptions of science and scientists do not differ, at least qualitatively, from those of the average adult. There appears to be a striking similarity to the politicians' view of science, particularly during the second world war and the cold war period following it. During this time scientific and technological progress received high priority and consequent financial support from governmental agencies.

It appears then, that the current approach being used in science education, as represented in this study, is promulgating the students' sense of remoteness of science and scientist. This, however, should not be attributed wholly to science teaching. The news media and popular entertainment such as films and science fiction television programs have certainly exerted a strong force and these non-school influences may be greater than those of the school.

The teaching of science, as represented in this study, does not seem to have been effective in helping students develop realistic perceptions of science and scientist. This is damaging in two ways. First, current thinking in science education places high priority on developing a view of science as a human endeavor and as a process. Second, in the case of the inner city youth, the remoteness of science could function as a block to personal ambition — saying, in effect, that inner city youths can never aspire to choosing a science-related career.

CHAPTER V

CONCLUSIONS

The use of modularized instruction appears to be a logical approach to increasing the effectiveness of science teaching in inner city schools. Modules incorporate the use of explicitly stated behavioral objectives which allow the student to be aware of what is expected of him. Modules also provide a greater degree of self-pacing for the learner than does non-modularized instruction. These features, coupled with frequent reinforcement in the form of completing relatively small increments of work, and the opportunity for guaranteed pupil success seem to provide viable instructional means for individualizing instruction.

In this study, an attempt was made to compare student attitude changes, student cognitive growth, and student cognitive retention in modularized and non-modularized junior high school science class. No significant differences were found between the control and experimental groups, indicating that components other than simple modularization of the material should be investigated.

The findings of the study must be tempered with several salient points. For one thing, both module and non-module classes showed greater than expected cognitive growth.

This may be due to the use of behavioral objectives. The specification of behavioral objectives was characteristic of a number of other programs for individualizing instruction (e.g., Kapfer and Swenson, 1968; Mager, 1962). The notion that learning can and should result in observable measurable changes in student behavior is intuitively satisfying at least for psychomotor and lower order cognitive skills. The syllabus within which this study was carried out involved mainly lower order cognitive skills such as remembering, simple inferring, and observing.

Both experimental and control groups worked toward the same behavioral objectives, thus removing differences due to the effect of the behavioral objective component. The achievement level and retention level, as measured by the test instrument for cognitive gain and retention appeared to be relatively high for the population involved in the study. This suggested that the use of behavioral objectives may have exerted a beneficial effect.

The provision for self-pacing was provided in modular experimental classes. Self-pacing was, according to the teachers, made use of by more highly motivated students. The less motivated students, according to the teachers, often fell behind though.

A concommitant part of self-pacing in modular instruction is the development and use of alternate learning activities. In this study limited provision for varied learning activities was made. This limitation applied to both the experimental and control groups. The effect was that both groups were exposed to the same, but a limited variety of, activities. In the studies reviewed (e.g., Kline, 1971; Mitzel, 1970), as well as the general model for individualization of instruction (which is ultimately the intent of modularization), much emphasis is placed on varied learning activities. This implied the availability of appropriate resources, and alternate learning routes. That there were little or no differences in the scope and depth of activities other that the software provided to the experimental group, largely removed any effects which might be attributable to differences in learning activities.

It was thought that the provision of short term goals (the usual module length was three or four class periods) would be sufficiently reinforcing to motivate the students. It appeared that, as is often the case, that which is reinforcing at one point in time ceases to be reinforcing as it becomes a normal, expected part of the routine. It was concluded that the reinforcement which may have been provided by modularization diminished as the students became accustomed to completing the modules in a relatively short time.

The lack of measurable attitude changes as a result of modularization of instruction suggests three alternate conclusions. The first possible conclusion is that the semantic differential technique lacked the sensitivity to detect changes which occurred. The second possible conclusion is that modularization simply does not exert enough of an effect to modify the school-related attitudes. The third alternative conclusion is that the school-related attitudes of the inner city child become highly stable by the time he reaches adolescence. These attitudes may be highly resistant, perhaps impervious, to modification by manipulation of the instructional format. None of the studies found in the literature dealt with the inner city early adolescent. It was therefore not possible to arrive at a conclusion which could be supported through corroborative research.

The significant trend toward a less favorable attitude toward music and the scientist was probably an artifact which devolved from the large numbers of statistical tests which were made. That is to say, as a large number of tests were made, spurious significant relationships may have appeared by chance alone. Yamamoto, Thomas, and Wiersma (1969), using the semantic differential technique also detected a trend toward "negativism" toward school-related concepts as a function of age, in their work with seventh and ninth grade students. The difference in time span (two years as opposed to nine weeks) along with the observation of significant changes in attitude toward only two of five school-related concepts in this study tended to support the notion that the changes were chance occurrences.

It was therefore concluded that much more than simply modularizing an existing syllabus is required to effect significant changes in attitudes or scholastic performance of the inner city junior high school student. If modularized instruction is to become a part of an instructional program, it should not simply consist of segmenting the subject matter into blocks of material and providing students with pretest, outlines and other materials. Rather, it would appear that a combination of carefully devised behavioral objectives, the provision of resources and materials for a wide range of learning activities, and extensive teacher preparation are necessary. The modular format would provide a convenient vehicle for a highly individualized instructional program but it would seem that if all of the factors discussed above are not present, then no advantage over well-organized conventional instruction could be expected. Thus it appeared that modularization may be useful as a framework for individualizing instruction; however, it alone seems not to significantly affect student attitudes or learning.

It was therefore concluded that curriculum developers who are interested in greater individualization of instruction through modularization should consider all of the components. The prognosis is, it would seem, poor for a program based solely on the segmentation of instruction into "modules". All of the components discussed, but particularly the activity centered approach, are probably necessary, if significant improvement of instruction is to be realized.

RECOMMENDATIONS FOR FURTHER RESEARCH

It was concluded that modularization of instructional materials does not measurably affect attitude or learning in the inner city junior high school science class. However, other studies (e.g., Kline, 1971; Fulton, 1971) have indicated that individualization of science instruction is more effective than group instruction. In the studies reviewed, the format for presentation was, however, essentially that of modularized instruction.

Perhaps the effects of modularization might manifest themselves if the time were extended to, for example, one full school year. The effects may be too subtle to show up after only nine weeks of modularized instruction, although it would appear that a trend which approached significance would have emerged in nine weeks.

It was also noted that the populations dealt with in other studies were not ones which could be classified as inner city. A study of the same design as this study but which was extended to include a comparison of inner city schools with suburban schools would provide information concerning the generalization of modularized instruction. It may be found that culture-related differences in reaction to modularized instruction emerge.

It may also be possible that if a total curriculum of an inner city school were modularized so that the students become accustomed to self-paced learning, significant benefits might be realized. This approach has been taken at the elementary level (see Education USA: Special Report, 1968). However, where the total curriculum has been modularized, other components, including resources, appropriate teacher training, and appropriate physical facilities have usually been present. Thus there is no evidence that modularization of a total curriculum would, in itself, affect the learning or attitudes of students. A comparison of totally modularized school with a matching non-modularized school might provide this evidence.

A characteristic of modularized instruction is the specification of behavioral objectives. In this study, both the modularly instructed (experimental) and the conventionally instructed (control) groups worked toward identical, explicit behavioral objectives. The experimental group was presented the objectives as part of the software of the module. The control group was not provided with the objectives. However, the teachers used the behavioral objectives in teaching both groups. The specification of behavioral objectives is a component of individualized or modularized instruction which should be isolated and studied in a manner similar to this study's investigation of the modularization component.

An important question which was not posed in this study was that of the effect of modularized instruction on student initiative. The development of personal initiative should, it would seem, be a high priority in any learning experience. To test this effect would probably require analysis of teacher and student anecdotal records of some sort — perhaps as simple as number and rate of student assignment completion.

Further development of the semantic differential is needed, especially in relation to the study of early adolescence, ethnic minorities, and the inner city population. The studies of Yamamoto and his associates (Yamamoto, Thomas, and Wiersma, 1969; Yamamoto, Thomas, and Karns, 1969; Thomas and Yamamoto, 1971) and this study have, barely "scratched the surface". The pervasive contamination of Evaluation factors with Activity and, to a lesser extent, Potency, implies that Activity is a component of Evaluation in the early adolescent.

With high speed computers for use in factor analysis along with the relative simplicity of administering semantic differential tests, much research could and should be carried out in the areas cited.

In summary, it seems fairly clear from studies of individualized instruction coupled with the inferences drawn from analysis of the semantic differential data that active involvement of the student in his own learning may contribute more to the success of his school experience than any other factor.

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APPENDIXES

APPENDIX A: Prototype Semantic Differential

INSTRUCTIONS

At the top of each page you will find the name of an item. Below the name of the item is a group of words. For each word on the left side there is the opposite word on the right side. Read each pair of words and put an "X" in the space that you feel about the item at the top of the page.

For example, if the item at the top of the page was "City" and the first scale was "KIND — MEAN" and the first thing that came into your mind was "a little bit mean" then this is how you would mark it.

CITY

KIND _____:_____:_____:_____:__X__:_____:_____ MEAN

If "real mean" was the first thing that came into your mind then you would mark it:

KIND _____:_____:_____:_____:_____:_____:__X__ MEAN

If you do not feel one way or another you would mark it:

KIND _____:_____:_____:__X__:_____:_____:_____ MEAN

If "kind or good" was what you first thought of, then you would mark it:

KIND __X__:_____:_____:_____:_____:_____:_____ MEAN

Do this for each item on the following pages. Do not think about a right answer, but be serious and careful to give your true feelings. As soon as you make up your mind, put down your "X" and go on to the next line. Do not go back and change any marks because what you feel will come out first.

Be sure to get your "X" in the spaces like this:

_____:_____:_____:__X__:_____:_____:_____

Please do not mark between the spaces:

_____:_____:_____:_____X_____:_____:_____

and do not mark more than one space on a line.

_____:_____:__X__:_____:__X__:_____:_____

CONCEPTS*

SCHOOL
TEACHER
SCIENCE TEACHERS
SCIENCE CLASS
SCIENTIST
SCIENCE

1. Good ____:____:____:____:____:____:____ Bad

2. Slow ____:____:____:____:____:____:____ Fast

3. Pleasant ____:____:____:____:____:____:____ Unpleasant

4. Active ____:____:____:____:____:____:____ Inactive

5. Warm ____:____:____:____:____:____:____ Cold

6. Soft ____:____:____:____:____:____:____ Hard

7. Dead ____:____:____:____:____:____:____ Alive

8. Near ____:____:____:____:____:____:____ Far

9. Weak ____:____:____:____:____:____:____ Strong

10. Valuable ____:____:____:____:____:____:____ Worthless

11. Happy ____:____:____:____:____:____:____ Sad

12. Loose ____:____:____:____:____:____:____ Tight

* separate page used for each concept

APPENDIX B: List of 25 Adjectives

GRADE ____________

SCHOOL ____________

On this page is a list of words. They are all adjectives. In the space on the right side of each word, put the word that you think is the most opposite. Do this for each word. If you cannot spell the word you want to use, spell it like it sounds. We can figure it out. You do not need to put your name on your paper. Just put what grade you are in and the name of your school.

Here is how you do it:

GOOD bad

1. FAST ____________
2. ACTIVE ____________
3. HOT ____________
4. SHARP ____________
5. ALIVE ____________
6. STRONG ____________
7. HEAVY ____________
8. THICK ____________
9. LARGE ____________
10. CLEAN ____________
11. VALUABLE ____________
12. KIND ____________
13. PLEASANT ____________
14. HAPPY ____________
15. NICE ____________
16. FAIR ____________
17. FRESH ____________
18. BEAUTIFUL ____________
19. SWEET ____________
20. HARD ____________
21. LOUD ____________
22. BRAVE ____________
23. ROUGH ____________
24. WIDE ____________
25. DEEP ____________

APPENDIX C: Revised Semantic Differential

INSTRUCTIONS

At the top of each page you will find the name of an item. Below the name of the item is a group of words. For each word on the left side there is the opposite word on the right side. Read each pair of words and put an "X" in the space that you feel about the item at the top of the page.

For example, if the item at the top of the page was "City" and the first scale was " KIND — MEAN" and the first thing that came into your mind was "a little bit mean" then this is how you would mark it.

CITY

KIND _____:_____:_____:_____:__X__:_____:_____ MEAN

If "real mean" was the first thing that came into your mind then you would mark it:

KIND _____:_____:_____:_____:_____:_____:__X__ MEAN

If you do not feel one way or another you would mark it:

KIND _____:_____:_____:__X__:_____:_____:_____ MEAN

If "kind or good" was what you first thought of, then you would mark it:

KIND __X__:_____:_____:_____:_____:_____:_____ MEAN

Do this for each item on the following pages. Do not think about a right answer, but be serious and careful to give your true feelings. As soon as you make up your mind, put down your "X" and go on to the next line. Do not go back and change any marks because what you feel will come out first.

Be sure to get your "X" in the spaces like this:

_____:_____:_____:__X__:_____:_____:_____

<u>Please</u> <u>do</u> <u>not</u> mark between the spaces:

_____:_____:_____:_____X_____:_____:_____

and <u>do</u> <u>not</u> mark more than one space on a line.

_____:_____:__X__:_____:__X__:_____:_____

CONCEPTS*

SCIENCE CLASS
SCIENTIST
SCIENCE

1. GOOD	____	____	____	____	____	____	____	BAD
2. SMALL	____	____	____	____	____	____	____	LARGE
3. SHARP	____	____	____	____	____	____	____	DULL
4. FAST	____	____	____	____	____	____	____	SLOW
5. WEAK	____	____	____	____	____	____	____	STRONG
6. PLEASANT	____	____	____	____	____	____	____	UNPLESANT
7. LIGHT	____	____	____	____	____	____	____	HEAVY
8. VALUABLE	____	____	____	____	____	____	____	WORTHLESS
9. ALIVE	____	____	____	____	____	____	____	DEAD
10. ACTIVE	____	____	____	____	____	____	____	INACTIVE
11. HAPPY	____	____	____	____	____	____	____	SAD
12. THIN	____	____	____	____	____	____	____	THICK

* separate page used for each concept

APPENDIX D: Research Semantic Differential

INSTRUCTIONS

Some words or things make you feel something when you see or hear them. This test is to see how you feel about some words. It is not to see what you know. It does not have anything to do with your grade. It has a word at the top of each page. There are 12 lines which have a word on the left side. The opposite of the word is on the right side. In between the words there are 7 spaces. If the word at the top of the page was "CITY" and the first line was "NICE" on one side, and "MEAN" on the other, this is how it would look:

CITY

1. NICE _____:_____:_____:_____:_____:_____:_____ MEAN

If you feel like CITY is a little bit mean you would do it like this:

CITY

1. NICE _____:_____:_____:__X__:_____:_____:_____ MEAN

If you feel like CITY is a little bit nice then you would do it like this:

CITY

1. NICE _____:_____:__X__:_____:_____:_____:_____ MEAN

If you feel like CITY is real mean do it like this:

CITY

1. NICE _____:_____:_____:_____:_____:__X__:_____ MEAN

Only use the blanks at the ends (like right next to NICE or MEAN) if you <u>really</u> feel <u>very</u>, <u>very</u> strong about the the word at the top of the page.

Only use the middle blank if you do not feel <u>anything</u> about the word at the top of the page. Some of the words like THIN and THICK may seem funny. Just think about how you feel about the word at the top of the page and put down the first thing that comes to your mind. Do not try to make any sense out of it.

Do this for each page. Be serious about how you answer. Do not worry about what your teacher or anybody will think. The only reason you put your name and school on the pages is to see if other tests you may take show the same kind of feelings.

Be sure you get your marks in the spaces and not between. Also be sure you do not mark more than one space.

Remember, this test is to see how you <u>feel</u> when you see some words.

CONCEPTS*

MUSIC
SCHOOL
SCIENCE CLASS
SCIENTIST
SCIENCE

1. GOOD	____	____	____	____	____	____	____	BAD
2. SMALL	____	____	____	____	____	____	____	LARGE
3. SHARP	____	____	____	____	____	____	____	DULL
4. FAST	____	____	____	____	____	____	____	SLOW
5. WEAK	____	____	____	____	____	____	____	STRONG
6. PLEASANT	____	____	____	____	____	____	____	UNPLEASANT
7. LIGHT	____	____	____	____	____	____	____	HEAVY
8. VALUABLE	____	____	____	____	____	____	____	WORTHLESS
9. ALIVE	____	____	____	____	____	____	____	DEAD
10. ACTIVE	____	____	____	____	____	____	____	INACTIVE
11. HAPPY	____	____	____	____	____	____	____	SAD
12. THIN	____	____	____	____	____	____	____	THICK

* separate page used for each concept

APPENDIX E: Factor Analysis of 60 Variable Semantic Differential

ROTATED FACTOR ANALYSIS OF 60 VARIABLE SEMANTIC DIFFERENTIAL

(decimal points omitted)
N=198

Factor I - Vigor of Science Class

Variable	Concept	Adjective Pair	Presumed Factor[1]	Factor Loading
27	science class	dull-sharp	A	766
25	science class	bad-good	E	764
30	science class	unpleasant-pleasant	E	761
35	science class	sad-happy	E	726
33	science class	dead-alive	A	638
34	science class	inactive-active	A	590
49	science	bad-good	E	432
23	school	sad-happy	E	427
54	science	unpleasant-pleasant	E	427
29	science class	weak-strong	P	423
59	science	sad-happy	E	368
51	science	dull-sharp	A	316
Factor II - Vigor of the School				
18	school	unpleasant-pleasant	E	764
21	school	dead-alive	A	713
15	school	dull-sharp	A	702
23	school	sad-happy	E	689
13	school	bad-good	E	657
17	school	weak-strong	P	581
20	school	worthless-valuable	E	579
22	school	inactive-active	A	565
16	school	slow-fast	A	453
57	science	dead-alive	A	279
54	science	unpleasant-pleasant	E	257
34	science class	inactive-active	A	253

Factor III - Vigor of the Scientist

Variable	Concept	Adjective Pair	Presumed Factor[1]	Factor Loading
44	scientist	worthless-valuable	E	804
39	scientist	dull-sharp	A	779
41	scientist	weak-strong	P	608
37	scientist	bad-good	E	559
46	scientist	inactive-active	A	538
42	scientist	unpleasant-pleasant	E	535
45	scientist	dead-alive	A	532
51	science	dull-sharp	A	443
47	scientist	sad-happy	E	440
56	science	worthless-valuable	E	437
40	scientist	slow-fast	A	369
8	music	worthless-valuable	E	336

Factor IV - Vigor of Music

Variable	Concept	Adjective Pair	Presumed Factor	Factor Loading
9	music	dead-alive	A	747
6	music	unpleasant-pleasant	E	739
1	music	bad-good	E	698
3	music	dull-sharp	A	692
8	music	worthless-valuable	E	617
11	music	sad-happy	E	593
10	music	inactive-active	A	581
8	music	weak-strong	P	538
2	music	small-large	P	337
4	music	slow-fast	A	269
53	science	weak-strong	P	253
29	science class	weak-strong	P	243

Factor V - Vigor of Science

Variable	Concept	Adjective Pair	Presumed Factor[1]	Factor Loading
59	science	sad-happy	E	648
57	science	dead-alive	A	627
54	science	unpleasant-pleasant	E	559
49	science	bad-good	E	515
53	science	weak-strong	P	506
47	scientist	sad-happy	E	496
51	scientist	dull-sharp	A	425
42	scientist	unpleasant-pleasant	E	383
58	science	inactive-active	A	373
45	scientist	dead-alive	A	370
37	scientist	bad-good	E	336
35	science class	sad-happy	E	291

Factor VI - Oppressiveness

Variable	Concept	Adjective Pair	Presumed Factor	Factor Loading
19	school	light-heavy	P	778
31	science class	light-heavy	P	607
24	school	thin-thick	P	558
55	science	light-heavy	P	531
43	scientist	light-heavy	P	475
36	science class	thin-thick	P	291
29	science class	weak-strong	P	230
41	scientist	weak-strong	P	221
52	science	slow-fast	A	-198

Factor VII - Acceptance of Middle Class Values

Variable	Concept	Adjective Pair	Presumed Factor[1]	Factor Loading
32	science class	worthless-valuable	E	621
56	science	worthless-valuable	E	570
58	science	inactive-active	A	566
46	scientist	inactive-active	A	485
20	school	worthless-valuable	E	324
10	music	inactive-active	A	322
34	science class	inactive-active	A	315
57	science	dead-alive	A	310
22	school	inactive-active	A	272
33	science class	dead-alive	A	263
54	science	unpleasant-pleasant	E	255
45	scientist	dead-alive	A	210

Factor VIII - Efficacy of Science

Variable	Concept	Adjective Pair	Presumed Factor	Factor Loading
26	science class	small-large	P	745
50	science	small-large	P	601
36	science class	thin-thick	P	542
53	science	weak-strong	P	372
38	scientist	small-large	P	338
29	science class	weak-strong	P	277
55	science	light-heavy	P	236
56	science	worthless-valuable	E	218
60	science	thin-thick	P	217

Factor IX - Efficacy of the Scientist

Variable	Concept	Adjective Pair	Presumed Factor[1]	Factor Loading
48	scientist	thin-thick	P	831
60	science	thin-thick	P	753
43	scientist	light-heavy	P	501
38	scientist	small-large	P	335
55	science	light-heavy	P	333

Factor X - Efficacy of Knowledge

Variable	Concept	Adjective Pair	Presumed Factor[1]	Factor Loading
14	school	small-large	P	708
38	scientist	small-large	P	575
42	scientist	unpleasant-pleasant	E	353
47	scientist	sad-happy	E	265
8	music	worthless-valuable	E	-265
40	scientist	slow-fast	A	226
41	scientist	weak-strong	P	212
16	school	slow-fast	A	210
1	music	bad-good	E	202
46	scientist	inactive-active	A	199
50	science	small-large	P	193

Factor XI - General Potency

Variable	Concept	Adjective Pair	Presumed Factor[1]	Factor Loading
7	music	light-heavy	P	721
50	science	small-large	P	410
24	school	thin-thick	P	-320
16	school	slow-fast	A	-312
45	scientist	dead-alive	A	-283
37	scientist	bad-good	E	-253
21	school	dead-alive	A	-231
51	science	dull-sharp	A	200
36	science class	thin-thick	P	-197
12	music	thin-thick	P	196
10	music	inactive-active	A	-196
38	scientist	small-large	P	188
		Factor XII - Academic Achievement		
28	science class	slow-fast	A	807
29	science class	weak-strong	P	377
52	science	slow-fast	A	340
5	music	weak-strong	P	-293
16	school	slow-fast	A	227
57	science	dead-alive	A	192
		Factor XIII- Efficacy of Talent		
2	music	small-large	P	733
5	music	weak-strong	P	413
46	scientist	inactive-active	A	310
34	science class	inactive-active	A	203
60	science	thin-thick	P	194
33	science class	dead-alive	A	189

Factor XIV - Sensory

Variable	Concept	Adjective Pair	Presumed Factor[1]	Factor Loading
4	music	slow-fast	A	790
16	school	slow-fast	A	356
29	science class	weak-strong	P	300
24	school	thin-thick	P	268
11	music	sad-happy	E	234
53	science	weak-strong	P	238
60	science	thin-thick	P	200
17	school	weak-strong	P	197

Factor XV - General Potency

Variable	Concept	Adjective Pair	Presumed Factor	Factor Loading
12	music	thin-thick	P	722
13	school	bad-good	E	-330
10	music	inactive-active	A	308
26	science class	small-large	P	273
7	music	light-heavy	P	253
43	scientist	light-heavy	P	239
36	science class	thin-thick	P	235
22	school	inactive-active	A	192

Factor XVI - Laboratory Enthusiast

Variable	Concept	Adjective Pair	Presumed Factor	Factor Loading
40	scientist	slow-fast	A	626
52	science	slow-fast	A	480
34	science class	inactive-active	A	-257
19	school	light-heavy	P	-227
55	science	light-heavy	P	226
57	science	dead-alive	A	-209
51	science	dull-sharp	A	209

APPENDIX F: Factor Analysis of 64 Variable Semantic Differential

ROTATED FACTOR ANALYSIS OF 64 VARIABLE SEMANTIC DIFFERENTIAL

(decimal points omitted)
N=198

Factor I - Vigor of the School

Variable	Concept	Adjective Pair	Presumed Factor[1]	Factor Loading
18	school	unpleasant-pleasant	E	761
22	school	inactive-active	A	722
23	school	sad-happy	E	691
15	school	dull-sharp	A	683
13	school	bad-good	E	638
17	school	weak-strong	P	601
22	school	inactive-active	A	595
20	school	worthless-valuable	E	585
63	(composite)	baddead-goodlive	AE	474
16	school	slow-fast	A	457
57	science	dead-alive	A	298
34	science class	inactive-active	A	275
		Factor II - Supportiveness		
62	(composite)	supportive-oppressive		-740
19	school	light-heavy	P	-722
24	school	thin-thick	P	-625
31	science class	light-heavy	P	-592
55	science	light-heavy	P	-556
43	scientist	light-heavy	P	-519
36	science class	thin-thick	P	-354
48	scientist	thin-thick	P	-222
64	(composite)	impotent-dynamic	AP	-189
22	school	inactive-active	A	-186
12	music	thin-thick	P	-181

Factor III - Vigor of Music

Variable	Concept	Adjective Pair	Presumed Factor[1]	Factor Loading
9	music	dead-alive	A	-758
6	music	unpleasant-pleasant	E	-731
1	music	bad-good	E	-679
10	music	inactive-active	A	-629
11	music	sad-happy	E	-625
8	music	worthless-valuable	E	-623
3	music	dull-sharp	A	-618
5	music	weak-strong	P	-507
63	(composite)	baddead-goodlive	AE	-346
4	music	slow-fast	A	-346
2	music	small-large	P	343
12	music	thin-thick	P	-282

Factor IV - Beneficence of the Scientist

Variable	Concept	Adjective Pair	Presumed Factor	Factor Loading
44	scientist	worthless-valuable	E	825
46	scientist	inactive-active	A	723
39	scientist	dull-sharp	A	716
45	scientist	dead-alive	A	622
41	scientist	weak-strong	P	621
42	scientist	unpleasant-pleasant	E	612
37	scientist	bad-good	E	599
56	science	worthless-valuable	E	542
63	(composite)	baddead-goodlive	AE	493
47	scientist	sad-happy	E	459
40	scientist	slow-fast	A	456
32	science class	worthless-valuable	E	434

Factor V - Vigor of Science Class

Variable	Concept	Adjective Pair	Presumed Factor[1]	Factor Loading
25	science class	bad-good	E	766
27	science class	dull-sharp	A	761
30	science class	unpleasant-pleasant	E	759
35	science class	sad-happy	E	717
33	science class	dead-alive	A	656
34	science class	inactive-active	A	590
63	(composite)	baddead-goodlive	AE	505
29	science class	weak-strong	P	435
49	science	bad-good	E	430
54	science	unpleasant-pleasant	E	422
23	school	sad-happy	E	418
59	science	sad-happy	E	356
		Factor VI - Action		
61	(composite)	diffuse-intense	A	-807
16	school	slow-fast	A	-549
4	music	slow-fast	A	-511
52	science	slow-fast	A	-506
40	scientist	slow-fast	A	-466
28	science class	slow-fast	A	-452
10	music	inactive-active	A	-217
59	science	sad-happy	E	-200
42	scientist	unpleasant-pleasant	E	-181

Factor VII - Dutifulness or Acceptance

Variance	Concept	Adjective Pair	Presumed Factor[1]	Factor Loading
14	school	small-large	P	-548
38	scientist	small-large	P	-394
47	scientist	sad-happy	E	-370
32	science class	worthless-valuable	E	356
56	science	worthless-valuable	E	352
64	(composite)	impotent-dynamic	AP	-308
42	scientist	unpleasant-pleasant	E	-285
58	science	inactive-active	A	283
20	school	worthless-valuable	E	251
52	science	slow-fast	A	205
33	science class	dead-alive	A	203
53	science	weak-strong	P	199

Factor VIII - General Potency

Variance	Concept	Adjective Pair	Presumed Factor[1]	Factor Loading
7	music	light-heavy	P	663
12	music	thin-thick	P	589
50	science	small-large	P	329
36	science class	thin-thick	P	-307
43	scientist	light-heavy	P	273
24	school	thin-thick	P	-267
37	scientist	bad-good	E	-252
38	scientist	small-large	P	212
13	school	bad-good	E	-209
32	science class	worthless-valuable	E	195
20	school	worthless-valuable	E	185

Factor IX - Efficacy of Science

Variable	Concept	Adjective Pair	Presumed Factor[1]	Factor Loading
64	(composite)	impotent-dynamic	AP	-704
26	science class	small-large	P	-623
50	science	small-large	P	-612
29	science class	weak-strong	P	-504
53	science	weak-strong	P	-478
36	science class	thin-thick	P	-409
38	scientist	small-large	P	-374
28	science class	slow-fast	A	-311
14	school	small-large	P	-310
17	school	weak-strong	P	-307
4	music	slow-fast	A	275
62	(composite)	supportive-oppressive	P	-272

Factor X - Remoteness of Science

Variable	Concept	Adjective Pair	Presumed Factor	Factor Loading
48	scientist	thin-thick	P	803
60	science	thin-thick	P	693
62	(composite)	supportive-oppressive	P	486
38	scientist	small-large	P	442
43	scientist	light-heavy	P	385
55	science	light-heavy	P	317
36	science class	thin-thick	P	267
50	science	small-large	P	229
64	(composite)	impotent-dynamic	AP	197
29	science class	weak-strong	P	-194

Factor XI - Vigor of Science

Variable	Concept	Adjective Pair	Presumed Factor[1]	Factor Loading
59	science	sad-happy	E	-631
57	science	dead-alive	A	-618
54	science	unpleasant-pleasant	E	-570
49	science	bad-good	E	-548
53	science	weak-strong	P	-431
51	science	dull-sharp	A	-422
58	science	inactive-active	A	-404
56	science	worthless-valuable	E	-360
47	scientist	sad-happy	E	-354
63	(composite)	baddead-goodlive	AP	-352
42	scientist	unpleasant-pleasant	E	-320
37	scientist	bad-good	E	-302

Factor XII - General Potency

Variable	Concept	Adjective Pair	Presumed Factor[1]	Factor Loading
2	music	small-large	P	-534
5	music	weak-strong	P	-528
3	music	dull-sharp	A	-385
55	science	light-heavy	P	-276
64	(composite)	impotent-dynamic	AP	-268
7	music	light-heavy	P	-266
40	scientist	slow-fast	A	-261
15	school	dull-sharp	A	-249
19	school	light-heavy	P	240
53	science	weak-strong	P	-208
32	science class	worthless-valuable	E	195
31	science class	light-heavy	P	-187

APPENDIX G: Achievement/Retention Test

DO NOT MARK ON ANY OF THE PAGES OF THIS TEST!

INSTRUCTIONS

1. Read the questions carefully.
2. Read all of the answers to the questions before you try to answer.
3. Pick the answer you think is best — some questions may look like they have more than one right answer.
4. Be careful about using "all of these" or answers like that, "all of these" will be the best answer to some of of the questions but not always.
5. If you are not real sure about how to answer, go on to the next question.
6. When you have gotten to the end of the test then go back and try to answer the ones you skipped. You may have thought of the answer or gotten a "hint" from other questions. Do not guess — yet.
7. When you get to the end of the test again, go back and guess at the ones you skipped. You have a better chance of guessing right than wrong.
8. Be sure you use a number 2 pencil to mark your answer sheet.
9. Be sure to get your marks inside of the little spaces — not outside.
10. Mark your marks "strong" enough and fill the space up like this [ ].
11. If you erase be sure you do a good job.
12. Do not put any marks on the answer sheet outside of the spaces.
13. Be sure you get the right number on the answer sheet for the question number on the test.
14. Do not give more than one answer to a question.
15. Do not mark on any of the pages of this test. Use your answer sheet for your answers.

TEST

1. The kind of telescope which uses a mirror to gather light is called a
   (a) conductor
   (b) refractor
   (c) collector
   (d) reflector

2. The kind of telescope which uses a lens to gather light is called a
   (a) conductor
   (b) refractor
   (c) collector
   (d) reflector

3. The more useful one of these types of telescopes is the
   (a) conductor
   (b) refractor
   (c) collector
   (d) reflector

4. The reason that telescope (that you picked in question 3) is more useful is that it
   (a) is easier to make
   (b) uses glass that does not expand as much
   (c) is easier to support
   (d) is all of these (a,b,c)

5. A telescope works by
   (a) changing light into electrical energy
   (b) splitting light into its spectrum
   (c) collecting light and magnifying the image
   (d) storing light on film to get a stronger image

6. Te get away from the glare of city lights and to get where the air is thinnest, observatories are usually built on
   (a) beaches
   (b) deserts
   (c) mountains
   (d) rivers

7. By use of time exposure photography, a camera is able to
   (a) take pictures of stars that cannot be seen, even with a telescope
   (b) change light into electrical energy
   (c) see through clouds and dust
   (d) photograph stars that do not give off radiation

8. One reason camera film is "better" than human eyes for astronomy is that it
   (a) can "store up" light, making a stronger image
   (b) can pick up radio waves
   (c) does not get old and weak
   (d) is not bothered by glare

9. A camera is also helpful because it
   (a) can see through clouds and dust
   (b) is cheap
   (c) can tell if a thing in the sky is moving
   (d) is not bothered by glare

10. The colors of the spectrum that go together to make up white light are:
   (a) black, red, green, yellow, brown
   (b) violet, blue, green, yellow, orange, and red
   (c) gray, blue, black, yellow, and pink
   (d) pink, yellow, gray, green, and brown

11. The kinds of radiation that stars give off and which <u>people</u> <u>can</u> <u>not</u> <u>see</u> are
   (a) cosmic rays and x-rays
   (b) ultraviolet and infra-red
   (c) radiowaves
   (d) all of these kinds (a,b,c)

12. A piece of glass that can separate light into its spectrum by "bending" each color a different amount is called a
   (a) lens
   (b) mirror
   (c) prism
   (d) telescope

13. Since each star has its own spectrum of light, astronomers can tell
   (a) what is in the star
   (b) if the star is moving away or toward the earth
   (c) how hot the star is
   (d) all of these things (a,b,c)

14. One thing that makes a radio-telescope useful is that it
   (a) can find stars that do not give off any light
   (b) is cheaper than regular telescopes
   (c) can tell what is in a star
   (d) can store up light to make a stronger image

15. A radio-telescope works by
   (a) focusing radio waves and changing them into electrical energy
   (b) bending light waves into radiowaves
   (c) focusing sound waves from stars
   (d) none of these (a,b,c)

16. The size of a star can be found from its
    (a) brightness
    (b) color
    (c) temperature
    (d) distance

17. A light year is the distance
    (a) from the sun to the earth
    (b) across the solar system
    (c) that a beam of light travels in a year
    (d) from the earth to the moon

18. If a star is not too far away, its distance can be found by
    (a) its temperature
    (b) the parallex method
    (c) its spectrum
    (d) its radio waves

19. An astronomical unit is the distance
    (a) from the earth to the moon
    (b) across the solar system
    (c) across the universe
    (d) from the sun to the earth

20. The hottest stars are
    (a) yellow
    (b) blue
    (c) red
    (d) white

21. A type of star whose brightness changes at different times is a
    (a) red giant
    (b) white dwarf
    (c) super giant
    (d) pulsating star

22. Astronomers believe that
    (a) a star has always been the same and always will be
    (b) were all made at the same time
    (c) form from dust and gas coming together
    (d) are hot rocks

23. Astronomers are pretty sure the universe is getting bigger because
    (a) they see stars moving around
    (b) some stars are getting less bright
    (c) the "red shift" in the spectrum of stars shows they are moving away
    (d) radio signals of stars are getting weaker

24. The "Big Bang Theory" says that the universe
    (a) started at a small place and exploded out like a bomb
    (b) will finally explode like a bomb
    (c) explodes out and then after billion of years, the stars and gas come together again and explode again, over and over.
    (d) stays the same but stars are being made in some places and dying out or exploding in other places

25. The "Steady State Theory" says that
    (a) nothing ever changes in the whole universe
    (b) things will be steady for a while and then the whole universe will explode
    (c) the universe explodes out and then, after billion of years, the stars and gas come together again and explode again, over and over
    (d) the universe stays the same but stars are being made in some places and dying out or exploding in other places

26. A big bunch of stars (million or billions of them) is called a
    (a) red giant
    (b) galaxy
    (c) spectrum
    (d) nebula

27. A great big cloud of dust and gas way out in space is called a
    (a) white giant
    (b) blue giant
    (c) nebula
    (d) spectrum

28. The sun makes its energy by
    (a) burning up the gases in it
    (b) changing hydrogen to helium
    (c) always having the same amount of energy
    (d) some way not known to scientists

29. The temperature <u>inside</u> the sun is
    (a) very cold
    (b) hundreds of degrees
    (c) thousands of degrees
    (d) millions of degrees

30. The sun is
    (a) about the same size as the moon
    (b) about the same size as the earth
    (c) a little bit bigger than the earth
    (d) a whole lot bigger than the earth

31. The sun will most likely
(a) always be the same
(b) change into a planet
(c) change into a red giant
(d) blow up (explode)

32. The planet which is closest to the sun is
(a) Mars
(b) Mercury
(c) Earth
(d) Venus

33. The planets that are nearest the earth are
(a) Mars and Venus
(b) Saturn and Jupiter
(c) Mercury and Saturn
(d) Uranus and Pluto

34. An inner planet which is covered with thick clouds so you cannot see its surface and which is about the same size as the Earth is
(a) Mars
(b) Mercury
(c) Saturn
(d) Venus

35. The reason the earth has life on it is most likely because it has
(a) water
(b) air
(c) the right temperature
(d) all of these (a,b,c)

36. The shape of the orbits (paths around the sun) is
(a) a perfect circle
(b) oval
(c) zig-zag
(d) not known

37. The biggest planet in our solar system is
(a) Urnaus
(b) Saturn
(c) Neptune
(d) Jupiter

38. The planet with the rings around it is
(a) Saturn
(b) Uranus
(c) Neptune
(d) Pluto

39. The planet that is farthest away from the sun is
(a) Saturn
(b) Uranus
(c) Jupiter
(d) Pluto

40. The <u>outer</u> planets are (except for one)
(a) made of gas
(b) made of rock (like earth)
(c) very hot
(d) give off their own light

41. The planet with pinkish-yellow and blue stripes of clouds and a big red spot on it is
(a) Saturn
(b) Jupiter
(c) Neptune
(d) Uranus

42. All but one of the <u>outer</u> planets have
(a) no moons
(b) one moon
(c) more than one moon
(d) six moons

43. Asteroids are
(a) pieces of rock and dust which form a "belt" around the sun between Mars and Jupiter
(b) the millions of tiny stars that looks like a shining cloud in the Milky Way
(c) red-hot gases that shoot out from the sun at different times
(d) clouds of gas and dust found in deep space a long way out

44. A piece of rock or iron which came from outer space and that hits the earth is called a
(a) meteor
(b) comet
(c) asteroid
(d) meteorite

45. A piece of rock or iron which came from outer space but burns up before it gets to the ground is called a
(a) meteor
(b) comet
(c) asteroid
(d) meteorite

46. Balls of dust and ice which orbit way out in the solar system and only get near the sun once in a while are called
(a) comets
(b) meteors
(c) asteroids
(d) planets

47. The moon's surface has
(a) mountains
(b) cracks called rills
(c) flat-lands
(d) all of the above (a,b,c)

48. The moon is
(a) bigger than the earth
(b) smaller than the earth
(c) about the same size as the earth
(d) about the same size as the sun

49. One thing about the moon that is easy to see through a telescope is its
(a) air
(b) water
(c) clouds
(d) craters

50. The moon's gravity "pulls" on the oceans of the earth causing
(a) storms
(b) tides
(c) waves
(d) rivers

51. The reason nothing can live on the moon is
(a) there is no air or water on it
(b) it is a ball of hot gas
(c) no life ever got there
(d) it is too close to the sun

52. A solar eclipse is caused by
(a) the moon getting between the earth and the sun
(b) clouds of dust and gas in the space
(c) the sun getting cooler for a while
(d) some unknown force

53. A lunar eclipse is caused by
(a) the earth getting between the sun and the moon
(b) clouds of dust and gas in the space between the moon and earth
(c) the dark side of the moon being turned toward the earth
(d) some unknown force

54. The moon goes around the earth in about one
(a) day
(b) week
(c) month
(d) year

55. A year is about the time it takes for
(a) the moon to go around the earth
(b) the earth to go around the sun
(c) our galaxy to make one turn
(d) the universe to make one turn

56. The inclination or tilt of the earth causes
(a) day and night
(b) the tides
(c) the month
(d) the seasons

57. Day and night are caused by the
(a) movement of the earth around the sun
(b) rotation of the earth
(c) tilting or inclination of the earth
(d) moon going around the earth

58. Standard Time Belts are set up because
(a) as the earth moves, around the sun, the amount of light changes
(b) as the earth turns, it becomes day-light at different times in different parts of the world
(c) as the moon goes around the earth the amount of light changes
(d) no one could agree on time so each part of the country and world set up its own system

59. When it is 8 o'clock in Houston, in New York it is
(a) 6 o'clock
(b) 7 o'clock
(c) 8 o'clock
(d) 9 o'clock

60. "Leap years" are to make up for the difference between
(a) the length of days in different seasons
(b) the moon's time and the length of a month
(c) the calendar year (365 days) and the time it takes the earth to go around the sun
(d) the speed of the earth when it is close to or far from the sun (perihelion and aphelion).

61. The earth's atmosphere is made up of
(a) air and clouds
(b) the oceans, lakes, and streams
(c) the dirt, rock and other solid parts of the earth
(d) melted rock and minerals

62. The earth's <u>hydrosphere</u> is made up of
(a) air and clouds
(b) the oceans, lakes, and streams
(c) the dirt, rock and other solid parts of the earth
(d) melted rock and minerals

63. The earth's <u>lithosphere</u> is made up of
(a) air and clouds
(b) the oceans, lakes, and streams
(c) the dirt, rock and other solid parts of the earth
(d) melted rock and minerals

64. The earth's outer, thin layer of rock and dirt is called the
(a) mantle
(b) inner core
(c) outer core
(d) crust

65. The next layer which is solid rock but is hot and heavier is called
(a) crust
(b) mantle
(c) outer core
(d) inner core

66. The layers which is probably made of melted (liquid) rock is called the
(a) crust
(b) mantle
(c) outer core
(d) inner core

67. The part which is a very hot solid, probably iron, in the center of the earth is called the
(a) crust
(b) mantle
(c) outer core
(d) inner core

68. A solid element or compound of inorganic (non-living) nature that comes from the earth's crust is called a (an)
(a) crystal
(b) regolith
(c) outcrop
(d) mineral

69. A substance which <u>cannot</u> be broken down into other simpler substances by chemical methods is called a (an)
(a) element
(b) compound
(c) mixture
(d) mineral

70. A substance which <u>can</u> be broken down into simpler substances by chemical methods is called a (an)
(a) element
(b) compound
(c) mixture
(d) mineral

71. A group of atoms or ions with a definite shape and arrangement is called a (an)
(a) rock
(b) mineral
(c) crystal
(d) element

72. The smallest piece of an element that has all of the characteristics of the element and which is made up of electrons, protons, and neutrons is called a (an)
(a) atom
(b) crystal
(c) compound
(d) metal

73. Quartz, graphite, sulfur, galena are all in the same class of substances. This class is called
(a) metals
(b) compounds
(c) elements
(d) minerals

74. Iron, copper, sulfur, oxygen, and hydrogen are in the same class of substances. This class is called
(a) metals
(b) minerals
(c) elements
(d) compounds

75. Iron sulfide, silicon dioxide (quartz), carbon dioxide, and sugar are in the same class of substances. This class is called
(a) minerals
(b) compounds
(c) elements
(d) mixture

APPENDIX H: Sample of Materials Used in Study

GUIDE FOR TEACHERS USING MODULES

The instructional module is simply an organizational format which prescribes specific learning outcomes and provides the flexibility for individual rates and styles of learning. By prescribing specific learning outcomes, the module removes the doubt in the mind of the student as to what is required. It, at the same time, simplifies the task of the teacher by specifying learning objectives. This allows more effective planning of instruction and testing for achievement.

Ideally the module is a complete package which contains behavioral objectives, tests for the achievement of these achievement of these objectives, and all of the learning activities, including laboratory exercises or experiments, including the necessary materials and equipment, and audio-visual aids. At this time, however, the equipment and facilities vary considerably among the various schools. This rules out, to a large extent, the use of a uniform set of supporting activities.

The use of modularized instruction has been used at the elementary level and at the college level with apparent success. While it appears to be a useful innovation at the middle school level, it remains unproven, particularly among inner-city schools. The purpose of this experimental use of modularized instruction is to test the effect of the modular method on student achievement and attitude. As the experiment is concerned only with the method, it is more important that certain of the learning experiences be uniform between experimental and control classes than among the experimental classes. Thus the experimental variable is the method and not the material. There are certain exceptions in terms of material, (e.g., Introduction and Pretest). These materials are essential parts of the module, and are thus a part of the method.

Returning to the use of modules, several items need to be clarified. The first of these is the role of the teacher. The teacher becomes a supervisor and facilitator rather than a source of information only. This is not to say that the teacher never informs, but the emphasis is far less on lecturing. Much of the teacher's verbal behavior will be that of explaining, expanding and clarifying. The teacher's relationship to the student will be more individualized in that certain of the students will need help while others are operating autonomously.

When large group instruction (such as lecturing, a film, or a set of worksheets) is used, please be sure that both your experiment (module) group and your control group both received the same material.

A major difference in the provision of learning activities exists between the experimental and the control group. Normally, laboratory activities are group activities; i.e., everyone does the lab at the same time. This conventional approach should be adhered to for the control group. However, in the module group the laboratory equipment should be made available to the student as he needs it. "Early finishers" can be utilized as equipment monitors in many cases. This is, admittedly, inconvenient but the nature of the lab work in this particular part of the course is such that the materials and equipment can be brought into the classroom on a lab cart.

Another difference in the provision of activities is the use of AV material. Again, whereas conventionally this material is presented to a class on a one-time basis, whenever possible, it should be available to the student as he needs it. This will probably only be possible in the case of film strips and transparencies. In the case of the control groups, though, please schedule strips and transparencies in the conventional manner.

The "Study Guide" is a part of the module but, as it is directed toward attainment of the objectives of both groups, you will probably want to use it as supplement to your regular lesson plan for the control group. It is extremely important that both groups are exposed to the same subject matter as the criterion test will be based on the behavioral objectives. If one group is exposed to subject material that the other group is not, it will be impossible to tell whether the method is having any effect.

Teacher Corps personnel in your school can usually assist in the development of some materials for student activities as well as other chores. We will assist in every way possible, as the introduction of modularized instruction is a major priority of the Teacher Corps project. The actual classroom and laboratory work will necessarily have to be carried out by you. The reason that this is necessary is that, if this form of instruction is adopted, there will not be additional teaching personnel in the room with teachers — at least in the immediate future. It would thus be unrealistic to adopt a program which requires such conditions.

As soon as problems develop, please inform the Teacher Corps team leader so that adjustments and modifications can be made as soon as possible.

Thank you very much for your cooperation and contribution to the quest for more effective teaching.

OUTLINE FOR CONDUCTING CLASS USING MODULES

1. Read through the module to be sure there are no serious prints or errors.

2. Distribute "INTRODUCTION" and read it aloud to student. Ask if everyone understands and explain if necessary.

3. Tell students that they will take a test at the beginning of the unit to see what they already know. Emphasize that no grade will be given for this test unless they make a passing grade (like 5 out of 6 correct answers). Explain that if they are able to pass this test they do not have to do the module. You may want them to help others, do enrichment activities, or simply go on to the next module.

4. Administer "PRETEST".

5. Read answers to pretest. Ask if anyone has an answer which he thinks is the same, but is worded differently. (The ensuing discussion will help establish the learning set for the module and is thus an important part).

6. If any student passes the pretest, check his paper carefully and question him orally if there is some doubt. Also be sure everyone is taking the pretest and not waiting until the answers are read out to mark his paper.

7. Distribute "STUDY GUIDE" to students who did not pass the pretest.

8. Go on to other activities of the module. Have equipment ready along with instructions for lab activities. Set off areas for various activities if possible.

9. Administer "POSTTEST" to individuals when they are ready. An area of the room should be set aside for taking the posttest.

10. Collect posttest as soon as they are completed. If you think some of the students have an urge to be "helpful", try to get them to help their friends learn the material rather than telling them the answers!

11. If a student does not make a passing grade on the module, direct him to go back and do whatever is needed to meet the objectives which he failed to meet. (You might also admonish him not to try to take the posttest prematurely next time!)

12. Cut letter grade one increment each time he takes posttest, but assist him so that he will not have to keep taking it.

(TEACHER'S GUIDE)

Module 1

TELESCOPES

A. General Educational Goal: To become familiar with the refractor and reflector telescopes, the principles involved in each type, and the use of telescopes in astronomy.

B. Behavioral Objectives (meet 5 to pass)
   1. Name the two general types of telescopes.
   2. Cite the primary difference between them.
   3. Cite at least one advantage that one type has over the other.
   4. Cite the two principles involved in teloscopy.
   5. Tell why observatories are usually placed on mountain tops.
   6. Name at least two major observatories.

C. Estimated average time for completion (EATC, hereafter). This includes time for (pre- and posttests, labs, films, etc.) 3 class periods.

D. Resources
   1. Namowitz and Stone: pp. 323-325, Section 1-4.
   2. Diagrams of refractor and reflector telescopes.
   3. Hartl optical disc (check with Physical Science teacher).
   4. Len sets, meter sticks, holders to make "telescopes".
   5. Tape recording of study guide (if available).

E. Vocabulary words
   1. Astronomy
   2. Telescope
   3. Observatory
   4. Refract
   5. Reflect
   6. Image

F. Prerequisites: Ability to read at or above grade four. (All of the modules are set at 4.0 - 5.0 reading level)

NAME ____________________

PRETEST ON TELESCOPES

Be sure to correct your wrong answers when you get your paper graded.

1. Name the two main kinds of telescopes.

2. Tell the main difference between them.

3. Give at least one reason why one type is more useful than the other.

4. What two abilities must a telescope have to make things appear closer and brighter?

5. Tell why most observatories are put on top of mountains.

6. Name two or more big observatories.

NAME ____________________

TELESCOPES

INTRODUCTION

This unit is about telescopes. They are very important tools to the scientist when he studies the stars, sun, and other objects in the sky. When you finish with this unit, you will know something about how telescopes work. This will help you understand how the scientist finds out about stars and other objects in the sky.

Here are the things you need to be able to do to pass this unit:

1. Name the two main kinds of telescopes.
2. Tell the main difference between the two main kinds of telescopes.
3. Give at least one reason why one of the kinds of telescopes is more useful than the other.
4. Tell the two abilities that a telescope must have to make things appear closer and brighter.
5. Tell why most observatories are put on top of mountains.
6. Name two or more big observatories.

As you learn to do each of these six things, write down the answers and put the paper in your notebook.

You will probably need to do some or all of the activities for this unit to be able to do the six things. Be sure you understand what you are doing, because the test questions may not be in the same words.

NAME________________

STUDY GUIDE FOR TELESCOPES

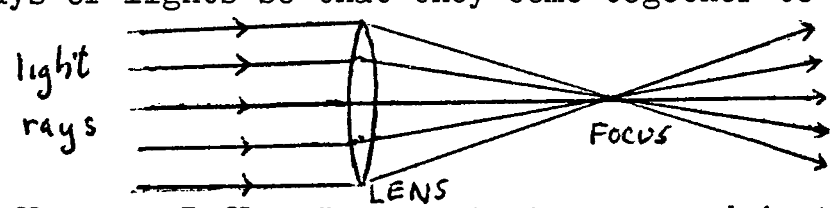
I. Important words in this unit

A. Astronomy: "Astro-" means star and "-nomy" means arrangement. A long time ago, "astronomy" meant studying how the stars were arranged in the sky. Now it means the study of a lot more, as you will see as we go through the next few units. A scientist who does astronomy is called an astronomer.

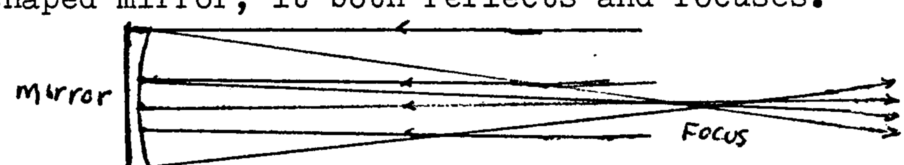
B. Telescope: "Tele-" means long and "scope" means looking or seeing. A telescope is for seeing things which are a long way away.

C. Observatory: "Observe" means "to look" as you already know ("observe" is from the Latin language of the Romans; "scope" means the same thing but is from the Greek language);"-tory" means "a place". An observatory is a place where you go to look at the stars.

D. Refract: "Refract" means "to bend". A refractor uses special pieces of glass called lenses which bend the rays of lights so that they come together to be focused:



E. Reflect: "Reflect" means to turn around in the opposite direction. A mirror reflects light. If it is a dish shaped mirror, it both reflects and focuses.



F. Image: What you see — like your "image" in a mirror or the "image" of a star that you look at.

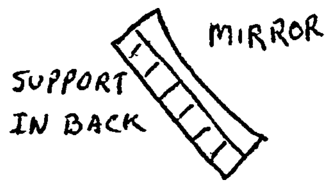
II. Types of Telescopes

A. Refractor

1. The oldes type — used by Galileo.
2. Uses lenses to focus the light.
3. Cannot be very big because big lenses change shape slightly because of their weight which makes them "droop". You can not tell by looking at them, but this change in shape messes up images that come through. They also expand (get bigger) and contract (get smaller) when they get hot or cold.

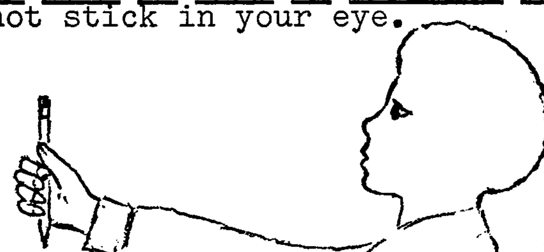
4. They are expensive to make.

B. Reflector
  1. Invented later by Newton (Newton was born the same year that Galileo died).
  2. Uses a dish shaped mirror to focus the light.
  3. Can be bigger than refractor because the mirror can be held up or supported from the back but a lens has to be supported by its edges. When the lens is supported only at the edge, it bends slightly.



  4. Mirrors are easier to make than lenses. They can be made of glass that does not expand as much as lens glass.
  5. Because of these things, reflector telescopes are cheaper.

III. How Telescopes make things look closer.
  A. Light gathering: This means that the telescope gathers light from a star or other object and pulls all of it all together. This makes the light stronger.
  B. Magnification: After the light has been gotten together it can be magnified. This is done by letting the image focus closer to your eye than you normally can. You can see how this works by holding your pencil or pen way out, and slowly bringing it toward your eye. Be sure to hold it pointing up, so that the point does not stick in your eye.

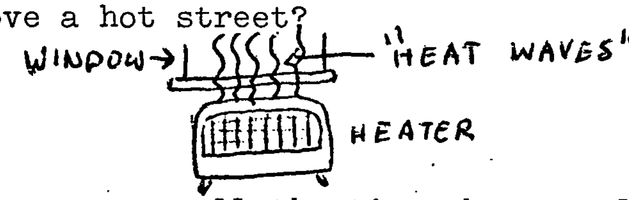


When it gets real close it gets "blurry" although it appears to get bigger. Magnification keeps this blurring from happening so that the image can keep getting bigger.

The reason for the "blurring" or fuzziness is that your eye's lens focuses a short distance in front of it, so if something is too close, it is out of focus. Try reading this with the paper real close to your eyes.

IV. Why observatories are usually on mountain tops (and why they cannot use bigger telescopes on earth).

A. Have you ever seen the "heat wave" about a stove or heater, or above a hot street?



B. The air has these waves all the time, but usually they are too weak to see. When a telescope is used, the waviness in the air is magnified just like the object being looked at.

C. Besides this, even on the clearest night the air is never completely clear of dust and water vapor.

D. These two things, when magnified, make the object less clear. The stronger the telescope, the more these problems mess up the image of the object being looked at.

E. Because of this, bigger, stronger telescopes would have more problems with the air. The 200 inch Mt.Palomar telescope is about as big as you can make a telescope and still get clear images.

F. The only way to get around this is to carry telescopes up above the air, like on a satellite or on the moon. Then there would be no air to cause these problems.

G. Since space ships with telescopes have just recently been developed there was no way to get above the air.

H. The best thing that could be done was to put observatories on top of mountains (this also gets the observatories away from city lights.

V. Some Important Observatories

A. The home of the world's biggest telescope is at the Hale Observatory on Mt. Palomar in California. This is a reflector.

B. The world's largest refractor is at the Yerkes Observatory at Williams Bay, Wisconsin.

C. Texas' main observatory is the McDonald Observatory on Mt. Locke in West Texas. It is used by the University of Texas.

D. Other important observatories include the Lick Observatory, the Mt. Wilson Observatory, both in California, Jodrell Bank Observatory in England, and the Crimean Astrophysical Observatory in Russia.

READ pp. 322; stop at "The Telescope as a Camera" on Page 325.

NAME________________

ACTIVITY ONE

This activity is for everyone to do for every unit. It will let you get the unit done much faster and with less work if you do it carefully. It will also let you read the book assignment faster and get more out of it. Be sure to ask questions if you don't understand something.

Go back to the "Introduction". Read number 1 in the list of items you should be able to do (objectives, for short).

Now turn to you Study Guide and read down the list. Did you find the information that lets you be able to do objective 1? If not, look at it again. If you still can not do number 1, ask for help. When you can do number 1, write down what you have found out.

Now, go to number 2. Do exactly the same thing for number 2 until you can do it.

Continue this until you have gone through all of the list of objectives.

Now, with the list of objectives for reference, read through the part of the textbook that covers the unit you are working on. The pages to read are listed at the bottom of the Study Guid.

After finishing this activity there will be one or more other activities that will help you understand the ideas of the unit. As you do these other activities keep the objectives in mind.

Now, you are ready to do another activity.

THIS IS THE SAME FOR EVERY UNIT,

BE SURE TO PUT IT WITH THE NEXT UNIT YOU DO.

NAME ____________________

POSTTEST ON TELESCOPES

Write your answer in the blank. When you get your paper graded, be sure to correct all wrong answers.

1. The two main types of telescopes are ____________________ and ____________________.

2. The kind of telescope which uses a mirror to gather the light is called a ____________________.

3. The kind of telescope which uses a lens to gather the light is called a ____________________.

4. The more useful one of these types of telescopes is the ____________________.

5. One reason the telescope you said is more useful is because ____________________.

6. One thing a telescope must be able to do is ____________________.

7. Another thing it must do after it does the first things is to ____________________ the image.

8. Tell why obervatories are usually put on top of mountains.

9. List two or more big observatories. You can use either the name of the observatory or the name of the mountain it is on.