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Wilson, Barbara Upton

**THE EFFECTS OF PACING AND COGNITIVE STYLE UPON STUDENT
ACHIEVEMENT AND ATTITUDE IN BASIC COLLEGE MATHEMATICS**

The College of William and Mary in Virginia

Ed.D. 1981

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THE EFFECTS OF PACING AND COGNITIVE STYLE
UPON STUDENT ACHIEVEMENT AND ATTITUDE
IN BASIC COLLEGE MATHEMATICS

A Dissertation
Presented to
The Faculty of the School of Education
The College of William and Mary in Virginia

In Partial Fulfillment
Of the Requirements for the Degree
Doctor of Education

by
Barbara U. Wilson
June 1981

THE EFFECTS OF PACING AND
COGNITIVE STYLE UPON STUDENT
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by

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B.U.W.

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CHAPTER I

INTRODUCTION

A marked change in the characteristics of the postsecondary student population has occurred in the past decade. With the reduction of geographical, financial, and academic entrance barriers, individuals and groups previously underrepresented in higher education -- such as adults, students from lower socioeconomic levels, and minorities -- have enrolled in ever-increasing numbers. These students, labeled "non-traditional" and "new students," differ significantly from traditional college students in terms of background experiences, personality characteristics, and entering academic competencies.

Many of these new students have mediocre high school records, backgrounds characterized by academic failure, and low scholastic aptitude as measured by traditional standardized tests (Messick, 1976, p. 25). According to the Carnegie Commission on Higher Education (1972) these new students have increased the diversity of the postsecondary student population:

The student community is now highly diverse in ability, in achievement, in ethnic and political orientation, in age and in academic and occupational interest -- and is becoming more so (p. 23).

Recent research findings, however, indicate that traditional instructional approaches (such as the lecture) do not account for individual differences among these students in cognitive style, prior learning, and the rate of acquisition (Goldschmid, 1976, p. 438). These findings have encouraged many institutions to engage in major

reforms in traditional methods of instruction, thus providing a better match to student needs.

New instructional systems involving modular courses, self-paced learning, and other forms of technology are being developed to meet the needs of these new students in terms of their differing aptitudes, learning rates, and learning styles. These reforms in instructional methods have led to a major trend in higher education; the individualization of instruction. This approach assumes that individualizing instruction, or tailoring instruction to each student as much as possible, will improve the overall quality of instruction and student learning.

The use of instructional technologies as an approach to individualization emphasizes the organization of the learning environment on predetermined programs that generally are fixed and inflexible. These programs try to identify the "one best way" to teach all things to all students. Kozma (1978) notes that this "one best way" approach focuses on the techniques of teaching and the media. According to Kozma, this approach

... rests on the premise that learning is essentially the same for all students and that the only thing that need be done to improve instruction is to find that technique or method which maximizes learning (p. 8).

These new instructional technologies include proctorial systems of instruction and self-pacing techniques such as programmed instruction (PI) and computer-assisted instruction (CAI). They are all learner- rather than teacher-oriented and emphasize clear goals, active student participation in the learning process, feedback and evaluation, and individual pacing. In short, they seek to account for emerging

principles of learning theories and at the same time adapt to individual differences (Goldschmid, 1976, p. 439).

A number of studies indicate that these individualized instructional programs produce significantly more positive student attitudes toward a course and higher achievement when compared to the traditional format (Mielke & Hill, 1977; Jernstedt, 1976; Kulik, Kulik & Smith, 1976; Robin, 1976; Taveggia, 1976; Semb, et al., 1975). However, while all of these instructional techniques appear to be effective for some students in a variety of settings, there is no clear evidence in the literature to establish superiority of one instructional method over another as the best individualizing procedure (Shalock, 1976, p. 48).

In response to the need for more effective teaching methods a number of postsecondary instructors have experimented with another flexible option -- Keller's Personalized System of Instruction (PSI). Research literature on PSI indicates that it is an innovative approach that has been effective in improving both students' attitudes toward a course as well as their performance on a variety of course achievement indicators when compared with students taught by a traditional approach (Kulik, Kulik & Carmichael, 1974).

Although the general findings on the effectiveness of PSI are favorable, the withdrawal rate from PSI courses is often very high (Robin, 1976). This might be due to the self-pacing feature of PSI courses which has produced student procrastination and high withdrawal rates. Researchers have sought to improve pacing and resolve the problems of high withdrawal rate by implementing instructor-paced schedules in place of student self-pacing in several PSI courses. Results of these studies indicate that although instructor-pacing modifies student

procrastination and withdrawal rate, it does not appear to influence academic achievement (Reiser & Sullivan, 1977; Bijou, et al., 1976; Fernald, et al., 1975; Goldwater & Acker, 1975).

One potential problem with the studies cited above, and with most PSI investigations, is that they fail to relate performance in PSI courses to learner traits and aptitudes. As a result, they may conceal the presence of interactions between distinct learner traits, on the one hand, and alternative instructional treatments, on the other (Pascarella, 1974, p. 1). It may be that the effects of pacing vary substantially across the full range of aptitudes or characteristics possessed by students in the course. Thus instructor-pacing may be more effective for one subgroup of students at certain levels of a particular trait, while self-pacing may be appropriate for another subgroup at different levels of the same trait; and, for still another subgroup, achievement may not be affected by instructional treatment at all.

The above factors raise serious questions about the "one best way" approach to instructional improvement. Kozma (1978, p. 9) points out that limiting the instructional question to "best method" ignores the uniqueness of the learner. Researchers now agree that the underlying question should be "What methods are best for what students and under what conditions?" (Kozma, 1978, p. 7; Cross, 1976, p. 111; Davis, 1976, p. 10).

In approaching this problem of understanding which students learn best under what conditions, recent instructional research has considered another approach to individualization. Whereas the "one best way" approach deals only with the methods or treatments of instruction, this new research includes a second element: the student. This approach to

individualization focuses on the characteristics (aptitudes) of each student and attempts to match instruction to the needs of individual learners.

Studies based on this approach are termed aptitude-treatment interaction (ATI) studies. Cronbach and Snow (1969) identify the major goal in ATI research as follows:

The task of research is to formulate more precisely the ways in which instruction can be varied so as to fit pupil characteristics (p. 1).

This trend of matching instruction to the needs of individual learners has led to an extensive search for influential individual difference variables. One such variable which might be related to the effectiveness of an instructor-paced or a self-paced method of instruction is cognitive style.

One of the most widely researched models of cognitive style is the field-dependence-independence dimension studied extensively by Witkin et al. (1974,1977). Research on the cognitive and personal characteristics associated with field dependence-independence has produced findings that may have implications for education. In an extensive review, Witkin (1976, p. 57) noted that a student's cognitive style may influence his or her way of learning, and that the extent of matches or mismatches on field dependence-independence has significant implications for the learning process.

The literature also supports the contention that the field-independent student is more likely to achieve success with self-pacing, an unstructured approach, than is the field-dependent student (Douglass & Kahle, 1978; McLeod et al., 1978; Renzi, 1974; Witkin & Moore, 1974). To understand which students learn best under what conditions, the

emerging area of research on cognitive style holds promise for improving the effectiveness of undergraduate instruction.

Statement of the Problem

The purpose of this study is to investigate the effects of two alternative instructional strategies for students of differing cognitive styles on academic achievement and attitudes in a basic mathematics course. The two instructional strategies are self-paced and instructor-paced, while the two cognitive styles are field-dependent and field-independent.

Research Hypotheses

Relative to the statement of the problem, the following hypotheses were made:

1. The self-paced group will exceed the instructor-paced group in withdrawal rate.
2. The field-dependent group will exceed the field-independent group in withdrawal rate.
3. The interaction between treatment and withdrawal rate will be greater than that between cognitive style and withdrawal rate.
4. The instructor-paced group mean score on a measure of achievement will exceed that of the self-paced group.
5. The field-independent group mean score on a measure of achievement will exceed that of the field-dependent group.
6. The interaction between cognitive style and achievement will be greater than that between treatment and achievement.
7. The instructor-paced group will demonstrate more favorable attitudes towards the course than the field-dependent group.
8. The field-independent group will demonstrate more positive attitudes towards the course than the field-dependent group.

9. The interaction between cognitive style and attitude will be greater than that between treatment and attitude.

10. The instructor-paced group will exceed the self-paced group in pacing rate.

11. The field-independent group will exceed the field-dependent group in pacing rate.

12. The interaction between treatment and pacing rate will be greater than that between cognitive style and pacing rate.

Need for the Study

The last two decades have witnessed a substantial increase in the number of "nontraditional" and "new" students enrolled in postsecondary institutions. These students, including adults and minorities, possess widely varying skills and abilities; consequently, many of them are experiencing difficulty with traditional academic work (Cross, 1976, p. 4).

Attrition among postsecondary students -- a problem that is especially apparent in "open admissions" schools -- may be a result of institutional failure to respond to the increasingly diverse needs of the changing student population. The differing needs of students should be analyzed and teaching techniques designed, implemented, and evaluated so that they provide a reasonable degree of success for the student in obtaining academic goals.

To alleviate the problems arising from the diversity in the capabilities of entering students, educators have turned their attention to lecture, discussion, independent study, media, computer-assisted instruction, individualized or personalized techniques (such as the audio-tutorial approach, mastery learning, the personalized system of instruction developed by F. S. Keller and his associates), as well as

other techniques in an effort to improve the learning process. Although these new techniques have sometimes met with success, these attempts suggest that no single instructional treatment is likely to maximize learning for every student. Rather than searching for a single best treatment, Cronbach (1957) has recommended that researchers should design alternate treatments that are tailored to suit students with specific characteristics or aptitudes.

George Domino (1971) showed how characteristics of the student can interact with the instructional situation. Domino studied the academic performance of high and low scorers on the Achievement-via-Conformance (Ac) and Achievement-via-Independence (Ai) scales of the California Psychological Inventory. Subjects were assigned to sections taught in either a conforming or an independent manner. Results of Domino's study indicated that neither teaching style was consistently better than the other for all students. However, he found that students taught in a manner consonant with their achievement orientation obtained significantly higher means on final exam scores and on teacher ratings.

Domino's study emphasizes the importance of including student traits in research studies. Had he ignored the student traits of Achievement-via-Conformance and Independence, his study would have resulted in no significant differences between structured and unstructured styles and would have no implications for college teachers. Results such as these emphasize the difference between the aptitude-treatment interaction approach and the less sensitive "one best way" approach.

Kozma (1978, p. 11) notes that ATI has several implications for teachers. The general consensus is: adjust instruction to the

characteristics (aptitudes) of the learner. For example, the same kind of instruction could be given to different students but in varying amounts. A student whose previous achievement level was low could be given supplementary reading assignments covering topics in which he is deficient.

Another method for adjusting instruction to the characteristics of the learner would be to provide different kinds of instruction to counterbalance student weaknesses or to capitalize on strengths. For example, students in PSI courses who have trouble structuring their environment (field-dependents) could be exposed to instructor-pacing; alternatively, students who perform best with less structure (field-independents) could be given self-paced instruction.

However, if this approach is to be useful, further evaluative research must be conducted. The research must attempt to find out which student aptitudes are important and how each can be linked effectively to alternative instructional approaches. Unfortunately, systematic aptitude-treatment interaction research has been conducted only recently with students on the college or graduate school levels. Kozma (1978, p. 11) and Witkin (1977, p. 57) conclude that the amount of research done so far has left researchers with few concrete results but a great deal of optimism.

While this neglect of learner characteristics has many bases, Witkin (1977) states that one widely shared assumption at the college level is that such issues no longer matter.

The advanced scholarship of the instructor and his devotion to his subject matter, on the one hand, and the strong motivation of students who have made the

voluntary choice to seek advanced training, on the other hand, are assumed to insure good teaching and good learning. I would seriously challenge this assumption (p. 57).

Witkin suggests that the results of studies with younger students on the importance of cognitive style in teaching, learning, and teacher-student interaction are probably applicable to older students as well. This suggestion makes a compelling case for extending this line of work to the higher education level. As a consequence, a few college mathematics instructors have begun to explore interactions between cognitive style and individualized instruction.

College mathematics instructors have indicated their interest in individualizing instruction by the number of articles on this topic which have appeared in the American Mathematical Monthly during the past several years. Attempts to individualize mathematics instruction have focused on two distinct approaches: organizational schema (proctorial and self-pacing programs) and the search for ATI's. Each of these approaches has had its weaknesses. Organizational studies have failed to consider the characteristics of learners. ATI studies, usually performed under carefully controlled and atypical classroom situations, have revealed that hypotheses tested in such studies have often not been found valid by classroom teachers (Eastman & Dietz, 1978, p. 46).

The weaknesses detected in the organizational approach and in the ATI approach indicate that there are problems in determining ways to provide individualized instruction that will help students learn mathematics and teachers teach mathematics. Eastman and Dietz (1978)

suggest that a possible solution may be to combine approaches instead of using them separately as was done in the past.

It is imperative that we solve these problems, and it also seems clear that it is time to consider the two approaches together since the problems in one approach are the strengths in the other. By dealing with both approaches simultaneously we may gain insight into how different students learn mathematics, improve our own teaching by using different kinds of instruction, obtain a greater understanding of the reasons for students' difficulties, and determine effective ways to group students for instruction (p. 46).

The above quotation by Eastman and Dietz (1978) suggests that in dealing with problems of classroom organization and individual differences it may be helpful to consider interactions between aptitude and instruction that result in success in mathematics learning. The combined use of organizational schema and an ATI approach provide a way to attack the problems of classroom organization and individual differences in a new way.

This investigation is designed according to the recommendation of Eastman and Dietz since it investigates interactions between cognitive style and method of instruction. It is hoped that this study will help to identify the extent to which cognitive style and method of instruction interact to influence achievement. Such an approach may be helpful in establishing programs which best meet the needs of students they are intended to serve.

Theoretical Rationale

The literature in higher education supports the premise that all students can learn. Bloom (1971, p. 51) suggests that even though students may differ in terms of skills, interests, personality, and

learning rates; they can learn if given the proper conditions for learning.

Much of the research on improving learning conditions has focused on individualized instruction systems. Although these systems have been effective in producing significantly higher examination performance and more positive attitudes toward college, they have largely neglected another equally important part of the teaching-learning process: how a person learns.

There is a considerable body of research suggesting that how a person learns and effectively absorbs information varies greatly from individual to individual. Each person has distinctive mental characteristics for transforming what he studies into knowledge with personal meaning. These mental characteristics are referred to in the literature as cognitive style.

One of the most widely researched cognitive styles is the field-dependence-independence dimension studied extensively by Witkin et al., (1977). The extremes of this dimension of cognitive style are exemplified by subjects placed along a continuum based on the ease with which they are able to perceive items as discrete from their backgrounds. The field-independent person perceives his environment in an analytic way, separating items from their backgrounds. The field-dependent person perceives his environment globally, seeing the whole rather than the parts.

Witkin's field-dependence-independence dimension of cognitive style identifies an aptitude variable that has been the object of research which relates directly to college teaching. Witkin and his associates carried out a major longitudinal study of 1600 graduates from a large municipal university in 1970. The researchers have

extensive data on the students enabling them to examine cognitive style and its relationship to a number of key academic factors (Claxton & Ralston, p. 10). This research, as well as a number of other findings over the past three decades, has provided a sound theoretical base for field-independence-dependence and a substantial amount of information on its relationship to the learning of mathematics (Witkin, Moore, Goodenough, & Cox, 1977; Witkin, Dyk, Faterson, Goodenough & Karp, 1962, 1974).

Witkin's theory of cognitive style predicts that field-independent students will perform better when allowed to work independently, and that field-dependent students will learn more when they have substantial help and attention from the instructor. Thus, field-independent students should be more inclined toward individualized methods than should field-dependent students.

Studies have also revealed that dependent students prefer clear directions and instructor responsibility, whereas independent students like to take responsibility for their own learning; similarly, field-dependent students are less likely than field-independent students to do well in organizing their learning materials (Witkin & Moore, 1974, p. 10).

Other field-dependent-independent studies examining the use of mediators have generally investigated situations in which the material to be learned lacks any clear inherent structure, thus requiring that the subject provide organization as an aid to learning. Results of these studies (Renzi, 1974; Greene, 1972; Koran, Snow & McDonald, 1971; Schwen, 1970) suggest that field-dependent persons are more likely to experience difficulty learning ambiguous material than are field-independent persons.

Utilizing a variety of personality assessment techniques, Witkin concluded that field-independent individuals function with relatively little support from the environment. The field-dependent person, on the other hand, needs environmental support, does not initiate activity, and is especially likely to be guided by authority figures in structuring the environment.

The findings outlined by researchers on field-dependence-independence imply that educators need to be able to develop cognitive strategies for teaching some basic subjects and some basic skills that all students need to learn. For example, a mathematician may have to develop a more personally interactive approach to help a field-dependent student learn mathematics (Cross, 1976, p. 131). Structured self-paced approaches such as PSI, for example, may be most useful for those students who need relatively little support in organizing their learning environments. According to Witkin et al., (1977), these would be the field-independent students. On the other hand, self-paced learning programs require that students work independently, taking full responsibility for their own learning. This learning environment is difficult for field-dependents, thus, implying that instructor-paced approaches may offer an especially useful alternative for these field-dependent students.

Even though students give self-pacing top ranking among course features contributing to their enjoyment of learning (Nelson & Scott, 1974) and the majority indicate that the burdens of self-pacing are not frustrating (Hoberock & others, 1974), research indicates that with no specific deadlines, many students procrastinate. These procrastinators may be field-dependents whose needs are not being met in a self-paced situation. Instructor-paced approaches, then, should

suit the needs of these relatively field-dependent students who prefer clear directions and instructor responsibility, and who also experience difficulty in organizing their own learning materials.

Self-paced and teacher-paced alternatives provide a basis for improved instructional practices such as matching instruction to the needs of the individual learner according to assessed cognitive style.

Several studies have shown a significant relationship between achievement and cognitive style (Root, 1978; Staszkiwicz, 1978; Berke, 1976). Terrell (1976) and Domino (1971) for example, reported that students with cognitive styles matched to the cognitive style of the instructional mode tend to achieve higher grades than to students who are nonmatched.

Definition of Terms

For purposes of this study, operational definitions are as follows:

Self-paced Group - students permitted to take module quizzes at their own rate within the experimental period.

Instructor-paced Group - students who took module quizzes according to a schedule of dates in a course calendar.

Cognitive Style - an individual's preferred manner of organizing and processing information in the context of learning.

Field-Dependents - individuals who scored below the mean on the GEFT.

Field-Independents - individuals who scored above the mean on the GEFT.

Module - a self-contained, independent unit of a planned series of learning activities designed to help the student accomplish certain well-defined objectives.

Pacing Rate - an individual's progression through the course at a steady pace or at an unsteady pace.

Steady Pace - never going two consecutive periods without passing a quiz.

Unsteady Pace - going at least two consecutive periods without passing a quiz.

Limitations of the Study

Because this study was conducted in a predominantly Black "open door" urban university, the findings of the study can only be generalized with confidence to students attending a similar kind of institution.

CHAPTER II

REVIEW OF RELATED LITERATURE

Educators have recognized the existence of individual differences in learning ability among students for many years. The main problem educators face is how to deal with such differences. Bloom (1971, p. 51) maintains that even though students differ in terms of skills, interests, personalities, needs, learning styles, and learning rates, they can learn if sufficient learning conditions are provided. However, Bloom and his followers admit that if success is to be achieved, numerous changes are needed in the instructional process.

Research on teaching effectiveness indicates that there is no one best approach that is good for all students, strongly suggesting that learning results from interaction between students and teaching techniques. Hence, educators should replace the question, "What is the best method?" with the question, "Best for what and for whom?"

Research pertinent to the problem described in this study will be examined in three major categories: 1) research related to individualized instruction; 2) research related to self-pacing and instructor-pacing in PSI courses; and 3) research related to cognitive styles, including a review of general characteristics of cognitive style models, and a review of research on the field-dependence-independence model.

Individualized Instruction

Open admissions in higher education has drastically changed student characteristics. As a result, students now entering postsecondary institutions possess widely varying skills and abilities. Recent findings

in educational research have prompted many educators to conclude that traditional instructional approaches, such as the lecture, do not respond to the increasingly diverse needs of this changing student population. As a consequence, educators and psychologists have begun to develop new instructional technologies to improve the ways in which these students are taught and evaluated.

This challenge is being met, in part, by the development of a system of instructional techniques based on the concepts and methods of learning theory introduced by B. F. Skinner (1954). The fundamentals of Skinner's behaviorally based instruction share the following basic features; 1) specification of course objectives; 2) master learning; 3) small lesson units; 4) active student involvement in the learning process; 5) self-pacing; 6) frequent and immediate feedback; and 7) frequent evaluation (Ruskin & Ruskin, 1977, p. 6). Basically, instructors who use individualized instructional methods assume that all students can learn the course content and that variations in the amount of time required to attain mastery are directly related to individual differences.

There are many approaches to individualizing instruction. The Personalized System of Instruction (PSI), developed by Fred S. Keller in the early 1960s, represents one method of individualized education that has received widespread recognition within the last decade. The Keller Plan (PSI) encompasses the principles of learning theory cited above and introduces another factor into the individualized process: the proctor. The majority of "personalized" courses are derivatives of PSI and include the following features; 1) the go-at-your-own-pace feature; 2) the unit-perfection requirement for advancement; 3) the

use of lectures and demonstrations; 4) the stress upon the written word; and 5) the use of proctors (Taveggia, 1976).

Clinton (1976, p. 1) notes that the Personalized System of Instruction has become perhaps the most widely adopted system of individualized instruction in higher education since it entered the public domain (Keller, 1968). Research on individualized instructional techniques has primarily been to compare a particular approach, such as Keller's Personalized System of Instruction (PSI), to a traditional approach, such as the lecture-discussion format, Reiser (1977); Calhoun (1976); Born & Whelan (1973); Born, Gledhill & Davis (1972); Riner (1972); and Sheppard & MacDermot (1970) are studies which indicate that, when compared to conventional lecture approaches, the general PSI model produces significantly more positive student attitudes toward a course and significantly higher achievement. The results of these studies are based on a variety of disciplines, including psychology, physics, mathematics and engineering.

McMichael and Corey (1969) compared a PSI course in psychology with a traditionally taught course. Out of a possible fifty points on the final examination, the traditional group scored an average of 34.3 points while the PSI group averaged 40 points. These results indicated a statistical significance in favor of the PSI students. A similar pattern was exhibited in terms of course ratings. The average scores out of a possible ten points were six for the control group and nine for the PSI group. These results were also statistically significant. In addition, follow-up studies conducted nineteen weeks and ten months after course completion indicated significantly better retention rates for students in the PSI group.

Jernstedt (1976) also compared a traditional with an individualized group in an undergraduate course. The unit completion activities for the individualized group involved the writing of short papers. The performance of the two groups was compared through the use of multiple-choice, short answer, and essay examinations. The traditional group performed significantly better than the individualized group on both multiple-choice exams (a midterm and a final). However, on the essay exam the individualized group was significantly better than the traditional. Students in the individualized group reported that the course produced more learning, involved more work, tended to be more flexible, and was more accurate in grading than students in the traditional section reported it to be. Jernstedt concluded that students under individualized instruction viewed their course more favorably than students under traditional instruction, but that individualized instruction produces superior performance to traditional instruction only when the unit completion activities of the individualized section are similar to the behaviors required on the examination instruments.

Peluso and Baranchik (1977) report similar results for the use of PSI in mathematics. Two models of self-pacing instruction, one of which is based on the Keller plan, were compared with instruction in the traditional classroom manner. In order to avoid finding differences among teaching methods which might be due to differing levels of student preparation, the analysis was restricted to those students who had been pretested in arithmetic computation. Thus, final exam performances of comparable students could be compared. The results were statistically significant in favor of the experimental group ($p < .05$).

Other studies on the personalized system of instruction also demonstrate its effectiveness as a method of instruction. McKeachie and Kulik (1975, p. 173) summarized the evaluative research on PSI in a recent article in the Review of Research in Education. They found that: 1) The Keller Plan is an attractive teaching method to most students; 2) Self-pacing and interaction with tutors is highly favored by students; 3) Several investigators reported higher student withdrawal rates for PSI sections than for traditional sections; 4) Content learning, as measured by final examination performance, in Keller courses, always equals, and usually exceeds performance in lecture sections; and 5) Students report that they learn more in PSI than in lecture courses.

In summarizing the research on PSI, Robin (1976) reviewed thirty-nine between-group comparisons of behavioral instruction and lecture-discussion methods. Only studies which utilized achievement measures (other than final grades) common to both groups were included. Each study was classified according to the following ten dimensions: sample size; variant of behavioral instruction; method of assignment of students to groups; initial demonstration of equivalence of groups; reliability of the common achievement measure; objective or blind scoring of the common achievement measure; magnitude of academic achievement; student attitudes on common self-report questionnaires; and withdrawal rates. For selected subsets of the thirty-nine studies, additional comparisons involved retention and study time.

In terms of academic achievement, thirty of thirty-nine comparisons resulted in significant differences in favor of behavioral instruction, whereas six reported equal performances; two included multiple comparisons within the same study, yielding significant differences favoring

behavioral instruction in one part of each study (Robin, 1976, p. 20). For the thirty studies that included sufficient numerical information, the analysis revealed a mean achievement of seventy-one per cent in behavioral instruction versus sixty-two per cent in lecture-discussion, yielding a nine per cent difference (Robin, 1976, p. 20).

Seven studies supplemented final examinations with follow-up examinations administered to samples of the original groups at 2- to 24-month intervals, permitting an analysis of the extent to which behavioral instruction facilitates long-term retention of knowledge. In every case behavioral instruction groups significantly outscored tradition instruction groups, averaging a thirteen per cent difference with a range of four per cent to twenty-two per cent (Robin, 1976, p. 21).

In addition to achievement, Robin (1976) notes that student attitudes have served as a major dependent variable for evaluating behavioral instruction. Several studies indicated that students expressed extremely positive attitudes (Kulik et al., 1974; Green, 1971; Keller, 1968). In particular, they singled out the attractiveness and value of self-pacing, proctors, small steps, and unlimited remediation (Nelson & Scott, 1974; Green, 1971).

Sixteen of the thirty-nine studies included attitude surveys administered to both the behavioral instruction and lecture groups. In fourteen out of sixteen cases, the results significantly favored behavioral instruction.

Robin (1976, p. 23) concluded from the thirty-nine studies in his review that behavioral instruction produces superior academic achievement, retention, and student attitudinal responses to lecture-discussion

systems. A highly consistent eight per cent to eleven per cent achievement gain occurred across instructional variants, class sizes, and academic disciplines.

Although the effectiveness of the Personalized System of Instruction is quite well established, it has encountered several implementation problems. One of the most disturbing problems with PSI is that it has relatively high rates of withdrawal (Barrera & Glasgow, 1976; Born & Whelan, 1973). Research indicates that the self-pacing feature of PSI may be associated with these rates of withdrawal (Born & Whelan, 1973). Self-pacing allows each student to proceed through course materials at his own pace. Thus, a student may decide to take a unit quiz at his convenience or when he is most ready to demonstrate mastery, rather than at a common time for all students which is determined by the teacher. However, some students are apparently not ready for assuming major responsibility for their own learning. Even though students rank self-pacing as one of the top features adding to the enjoyment of learning (Nelson & Scott, 1974), seventy-one per cent of the faculty respondents to a survey in a PSI Newsletter, reported difficulty with student procrastination (Cross, 1976, p. 99). Although some students start working immediately after a course begins, a sizeable number of students procrastinate, fall behind schedule and fail to complete many course units near the end of the semester. The result is minimum learning and a lower grade (Roberts et al., 1978).

Summary: Research in education supports the premise that when compared to traditional approaches, the Personalized System of Instruction produces significantly higher achievement and produces

significantly more positive student attitudes toward a course (Reiser, 1977; Calhoun, 1976; Born & Whelan, 1973; Born, Gledhill & Davis, 1972; Riner, 1972; Sheppard & MacDermot, 1970). However, high rates of withdrawal represents one of the major problems of PSI. Research indicates that the self-pacing feature of PSI may be associated with these high withdrawal rates (Barrera & Glasgow, 1976). Further study is necessary to develop means for counteracting problems of procrastination and high withdrawal rates in PSI courses.

Self-Pacing and Instructor-Pacing in PSI Courses

To counteract problems of procrastination and high withdrawal rates in self-paced programs, educators have implemented instructor-paced schedules for student progress (Morris, Surber, Bijou, 1978; Reiser & Sullivan, 1977; Fernald et al., 1975; Goldwater & Acker, 1975; Miller, Weaver, & Semb, 1974). In those studies conducted, investigators have imposed deadlines which specify the day on which a unit quiz has to be taken, the date by which a unit quiz has to be taken, or the minimum rate of progress which has to be maintained (Robin, 1976, p. 28).

In 1977, Reiser and Sullivan designed a study to investigate the effects of instructor-pacing and self-pacing in a PSI course on student withdrawal rate, achievement, and attitudes. Only sixty-two undergraduates participated in the study. For the instructor-paced group, deadlines were imposed which specified the date by which a unit quiz had to be taken to earn a grade of A, B, C, or D. Instruction consisted of fifteen units in a textbook developed by the instructors of the course. Achievement measures consisted of the 10-item unit quizzes over each of the fifteen units and a comprehensive final examination. A five-choice, Likert-type attitude scale containing twelve statements about the course

was also administered to the students immediately upon completion of the final examination.

Results indicated that the withdrawal rate of the instructor-paced group was significantly lower than the rate for the self-paced group at the .05 level. The number of unit quizzes passed by students who completed the course did not differ significantly between treatment groups. On the final examination, the difference in mean scores between the groups was not statistically significant. Mean attitude survey scores did not differ significantly between the two treatment groups. These scores indicated that in both groups, overall student attitude toward the course was moderately positive.

Morris, Surber, and Bijoù (1978) conducted a study involving 149 undergraduate students enrolled in a PSI course using course materials divided into fifteen units. Students in the instructor-paced group worked within a flexible point system which required them to master at least one unit of material each week. The primary achievement measures was a 53-item posttest. A course evaluation questionnaire was also administered upon completion of the course. Nine months following completion of the semester, a retention test was administered.

Results for this study indicated that there was no difference in course withdrawal rate between the self-paced and instructor-paced groups. No differences in final grade distributions were reported; over 90 per cent of the students in both groups received an A. At the end of the course, the average number of units completed by each group was virtually the same. The two groups also performed almost identically on the 53-item pretest.

There was, however, a statistically significant difference between the two groups in terms of number of quizzes repeated over the course of the semester. Students in the self-paced group had to repeat 4.1 per cent of their quizzes, whereas those in the instructor-paced group had to repeat 7.2 per cent of theirs.

When compared with the pretest scores, the main effect of the pretest-posttest was significant while neither the main effect of the treatment nor the Treatment x Pretest - Posttest interaction approached significance. The performances of the two groups on the multiple-choice criteria tests increased significantly from the pretest to the posttest, but the two groups did not differ in their scores on either. In other words, it made no difference whether the students self-paced and procrastinated or whether they worked at an even rate under point incentives; they scored identically on the posttest achievement measure.

Data on retention indicated a strong test (pre-, post-, retention) main effect, but indicated that the Group x Test interaction was not statistically significant. However, the p value for the Group x Test interaction suggested that the self-paced group performed somewhat better on the retention test than did the instructor-paced students.

The results of this study are in agreement with other research demonstrating that whether students self-pace or have their pacing regulated, they score similarly on criterion measures of course achievement (Reiser & Sullivan, 1977; Burt, 1975; Bitgood & Segrave, 1975) and are equally satisfied with the ways in which they are instructed.

Fernald et al. (1975) observed that most studies treat PSI as a single global factor, and thereby provide little indication as to which PSI factors contribute most to its success. Accordingly, they designed a study which would systematically manipulate PSI factors.

Fernald et al. (1975) conducted a study involving two hundred fifty-five undergraduate students in a course where administration of the unit quizzes varied along three instructional dimensions: teacher versus student pacing, perfection versus no perfection requirement, and much versus little teaching assistant contact. The course was actually "two courses," each running for half of the semester. Three types of dependent variables were observed: (1) quiz and exam performances, (2) preference ratings for the different instructional approaches, and (3) evaluations of the course. Results indicated that quizzes were primarily responsible for discrimination on the pacing factor, where the student-paced groups scored significantly higher than the teacher-paced groups. Most students held moderate to strong preferences for much TA contact and student pacing, and mixed preferences with regard to the perfection requirement. With regard to overall evaluation of the first course, no main effects or interactions were noted for the different instructional variables. For the second course, on the other hand, students who were student-paced gave significantly higher course ratings than students who were teacher-paced.

Goldwater and Acker (1975) designed a study to examine the merits of a system of high performance demand and short assignment length within the context of instructor-pacing and mass-testing as opposed to self-pacing and individual-testing. Two hundred thirty-four students were randomly assigned to either a Mastery Performance (MP) group or to a control group. The conditions of the two groups were reversed in the second term so as to provide each student with exposure to both programs.

Results of the final examination data from the first term revealed a substantial advantage for the MP students over the Controls. Performance on the second term final examination, on the other hand, did not

distinguish between the two groups.

A follow-up was conducted in the first week of classes in the next school year to test long-term retention of the text material. MP students from the first term did significantly better on items from the first term than did those students who were in the Control group in the first term. There was no significant difference in performance on the second term items. Thus, the superiority of the first term MP group over the first term Controls seems to have persisted when measured some nine months later.

In summarizing the research evaluating the effect of self-paced and teacher-paced behavioral instruction, Robin (1976) concluded that

... (a) self-pacing is often associated with procrastination; (b) both deadline and positive incentive systems can effectively combat procrastination and produce steady, evenly distributed rates of unit completion; and (c) limiting self-pacing has no effect on academic achievement (p. 330).

In reflecting on the variations, outcome studies, and component analyses reviewed, Robin (1976, p.344) indicated that researchers in behavioral instruction need to design studies to determine what variables are preventing every student from scoring 100 per cent on posttests. To accomplish this end, a great expansion in interaction research on student characteristics, course materials, and behavioral instruction is a necessity. Self-pacing may be the most important element for some students who learn by working independently, while this approach may not suit the needs and interests of other students who can benefit more from a highly structured teacher-paced method.

Summary. Research findings indicate that self-pacing is often associated with high withdrawal rates and procrastination. Instructor-paced approaches have been used to counteract procrastination and

withdrawal problems. Research evaluating the effect of self-paced and instructor-paced programs reveal that deadline and positive incentive systems can result in evenly distributed rates of unit completion and significantly lower withdrawal rates. Data on posttest achievement measure indicate no statistically significant difference between self-paced and instructor-paced groups. Mean attitude survey scores, in a majority of studies, did not differ significantly between the two treatment groups. These scores indicated that in both groups, overall student attitude toward the course was moderately positive.

Cognitive Styles

Educators and psychologists have long been aware of and studied the individual differences among students in a given classroom. A number of personality and intellectual factors have been explored that might explain these variations among learners. Within the last two decades, matching instruction to the needs of individual learners has become the focus of major research efforts. This type of research is referred to in the literature as aptitude-treatment interaction (ATI) research. It is based on the premise that educators cannot ignore interactions between student aptitudes and treatments, but rather must adapt instructional treatments to student differences (Cronbach & Snow, 1969).

One of the most interesting and potentially useful aptitudes explored in this area has been an information-processing variable called cognitive style. Cognitive style refers to an individual's preferred manner of organizing and processing information in the context of learning. Evidence accumulated in the course of more than twenty years of research indicates that each individual has characteristic ways of collecting and organizing information into useful knowledge. Variations in these modes of information processing define cognitive style.

Cognitive style has not been developed and studied as a single entity. At least twelve different models have been identified and subjected to systematic theoretical and empirical examination (Claxton & Ralston, 1978; Messick, 1976; Kogan, 1971).

General Characteristics of Cognitive Style Models. Research involving each of the different dimensions of cognitive style has provided an extensive body of literature over the past two and a half decades. This literature provides an overview of the essential characteristics of cognitive style.

One significant characteristic of cognitive style is its apparently minimal relationship with measures of ability (Ausburn & Ausburn, 1978; Messick, 1976). While several studies have statistically significant correlations between some cognitive styles and standard IQ tests, these correlations have been questionable and generally too small to be of practical significance. Kogan (1971, p. 245), therefore, suggests that it would be wise to control for intelligence when relationships between cognitive styles and other variables are studied. Ausburn and Ausburn (1978, p. 340) suggest that a single cluster of subtests emphasizing a particular skill may account for the obtained relationship between total IQ and cognitive style.

Another important characteristic of cognitive style is its generality and stability over time and across a wide variety of tasks. Even though there are exceptions, most cognitive styles are internally consistent and relatively stable over time. This stability makes stylistic dimensions especially useful in language guidance and counseling (Witkin et al., 1977, p. 15).

A third characteristic of cognitive style is that it can be assessed by nonverbal or perceptual methods. Since perception can be assessed by objective, controlled techniques, perceptual performance may be used as a measure for identifying an individual's cognitive style. This use of nonverbal perceptual techniques to assess an individual's cognitive style helps avoid the penalty endured by New Students on assessment instruments that are primarily verbal (Witkin et al., 1947, p. 15).

A fourth important characteristic of cognitive style is that, with regard to value judgments, it is bipolar. This aspect of cognitive style is particularly significant in distinguishing cognitive style from intellectual abilities. Abilities vary, with increasing levels implying more and more of a certain facility. Cognitive styles range from one extreme to an opposite extreme, with each end of the dimension having different implications for cognitive functioning (Messick, 1976, p. 10). With cognitive style, then, each pole has adaptive value relative to specified conditions, and may be judged positively in regard to those conditions. For example, Quinlan and Blatt (1972) compared psychiatric student nurses to surgical nurses on tests of field-dependence-independence. Both groups were judged to be highly skilled by their peers. Whereas the psychiatric group was found to be relatively field-dependent, the surgical group was relatively field-independent. This outcome may be judged positively in regard to specified conditions since the job description of each group is in line with the makeup of the individuals.

Witkin et al., (1977, p. 17) point out that the more neutral bipolar characteristic of cognitive style makes it a less threatening concept to people than abilities or intelligence. Therefore, it is easier to convey information about an individual's cognitive style directly to him, than it is to convey information about his abilities.

The Field-Dependence-Independence Model. Substantive research has been conducted on each of the cognitive style models identified to date. However, Kogan (1971) has noted that

until recently there has been an almost total lack of articulation... between the psychological study of cognition, on the one hand, and educational research and practice, on the other (p. 243).

Within the last fifteen years there has been some attempt to bring cognitive psychology and education more closely together. Researchers and practitioners have begun to focus on cognitive processes in ways directly relevant to problems of research. Several cognitive style models have been utilized in this research.

Of all the cognitive style models identified, the field-dependence-independence dimension is the most widely known and thoroughly researched; more than two thousand studies are referenced in two major bibliographical searches of the literature on field-dependence-independence (Witkin, Cox & others, 1974; Witkin, Ottman & others, 1973). This dimension has also had the widest application to educational issues (Witkin, Moore & others, 1977; Witkin, 1976; Witkin, Dyk & others, 1962-1974; Witkin, Lewis & others, 1954, 1972).

The field-dependence-independence dimension of cognitive style was first introduced in 1954 by Witkin and his associates (Witkin, Lewis & others, 1954). Their approach to the measurement of cognitive style was based on the study of perception.

Witkin et al., (1971) defined cognitive style as

the characteristic, self-consistent modes of functioning which individuals show in their perceptual and intellectual activities. These cognitive styles are manifestations

in the cognitive sphere of still broader dimensions of personal functioning which cut across diverse psychological areas (p. 1).

Witkin's interest in cognitive style relates to perception of the upright specifically, in the distinction between global and analytical ways of perceiving objects and situations. The analytic/global continuum concerns the extent to which individuals are able to overcome the effects of distracting background elements (the field) when they are trying to differentiate important aspect of a given situation (Sigel & Coop, 1974, p. 254). The analytic person can deal with the elements independent of their distracting background, whereas the global person cannot free the elements from the distracting background. Persons who operate in an analytic manner are said to be field-independent, and those who operate in the more global manner are designated field-dependent.

Recent evidence implies that this dimension deals not only with perceptual and intellectual domains, but extends into the personality domain as well. In the cognitive realm, persons with an analytic cognitive style are likely to analyze a field when it is organized, and to impose structure on a field that lacks organization of its own. On the other hand, persons with a global style are more likely to accept the field as it is, without using such mediational processes as analyzing and structuring (Witkin et al., 1977, p. 21).

Studies of organizational factors in learning have been designed to illustrate the fact that field-independent people more often make use of mediators. Witkin et al., (1977, p. 21) concluded that when material to be learned lacks clear structure, field-dependent persons are likely to have greater difficulty in learning such material compared to field-independent persons who can themselves provide the mediating structured

rules necessary to facilitate learning. When the material to be learned is presented in an already organized form, so that structuring is not particularly needed, field-dependent and field-independent persons are not likely to differ in their learning.

Studies investigating the relation of field dependence-independence to the use of mediators is substantial and varied. In one study, Renzi (1974) varied the amount of feedback given the learner in an undergraduate programmed instruction approach. The Group Embedded Figures Test was used to determine cognitive style. The individuals were then randomly assigned to one of the two treatment groups. Each student was required to learn to draw an ellipse. One treatment group was given a self-instructional program with no feedback about their performance when they attempted to draw the ellipse. The other group was given the same program with feedback in the form of a correctly drawn ellipse provided as an overlay in the text. Both groups were given the same post-instructional test immediately upon completion of the program. Results indicated the performance of relatively field-independent students was not affected by whether or not they received feedback in the program. On the other hand, field-dependent students performed significantly better on the posttest when feedback was provided in the program.

In a second study, Marchese (1978) examined the effect of interaction between two levels of cognitive style (global and analytical) and two levels of instruction which varied in degree of structure from low (material-rule) to high (rule-material). The study was conducted in an undergraduate nursing course involving 60 female students. The findings supported the Cognitive Style x Treatment interaction effect that global (field-dependent) students would learn better in high than

low structure; while analytical (field-independent) students would learn better in low than high structure.

In a third study concerned with structure, Horak (1978) investigated the possible interactions between inductive and deductive teaching methods and the field dependence-independence cognitive style dimension. The subject matter taught was selected concepts from transformational geometry. The criterion measures included an overall achievement test which contained knowledge, application, analysis and transfer subtests. The sample included 118 undergraduate students and utilized the Group Embedded Figures Test to classify students as field-dependent or field-independent.

The results of this study were not in agreement with the conjectures of Witkin et al., (1977) that the field-dependent students would learn better under a deductive teaching method while the field-independent student would learn better under an inductive approach. The results of this study indicated the possibility that the field-dependent students learned more, as measured by the overall achievement and transfer test, from the inductive method.

In the inductive method, students spent time working problems and at times comparing their solutions with those of students around them. This was not the case in the deductive method. Horak concluded that a possible cause for the lack of a significant difference on the criterion measures for the more field-independent learners was this characteristic of social interaction.

Consistent with the findings of Renzi (1974) and Marchese (1978) on field-dependent people's greater needs for external structuring were the findings in an analysis of teachers' responses to a questionnaire

distributed by Witkin et al., (1977, p. 23) in a study on students of different cognitive styles. The results indicated that relatively dependent students prefer clear directions and instructor responsibility, whereas more internally directed students prefer to assume responsibility for their own learning; similarly, field dependents are less likely than field-independents to do well in organizing their own learning materials (Cross, 1976, p. 128).

The characteristics of field-dependents and field-independents cited above suggest that knowledge about student learning styles have implications for educational practice, especially for individualized learning approaches such as PSI. These approaches may be most useful for those students who need structure and organization to guide their learning efforts. Witkin (1977) labels these as field-dependent students. On the other hand, individualized learning approaches require independence and fail to stimulate interpersonal cooperation, which may be difficult for field-dependents. Cross (1976, p. 130) implies that perhaps, then, the peer tutors and the mentors of PSI may be considerably important to field-dependents and probably to many, if not most, New Students, since these two groups are somewhat similar in their profiles (Cross, 1976, p. 130). A more successful approach, then, to working with New Students might be to design clear, well-structured learning tasks that can be pursued under the guidance of an authority figure who imposes the structure and accepts responsibility for organizing the learning materials. This approach would be beneficial to students who are experiencing failure as a result of the self-pacing feature of PSI.

Even though students give self-pacing top ranking among course features contributing to their enjoyment of learning (Nelson & Scott, 1974)

and the majority indicate that the burdens of self-pacing are not frustrating (Hoberock & others, 1974), research indicates that with no specific deadlines many students procrastinate. If deadlines are imposed, the teacher has more control and the deadline may give the student more impetus to work on the course objectives. If the student fails to complete the objectives during the assigned time, however, there may be detrimental effects due to insufficient learning of prerequisite skills needed for learning future materials. This teacher-paced approach, then, should suit the needs of the relatively field-dependent students who prefer clear directions and instructor responsibility, and who also experience difficulty in organizing their own learning materials.

Most of the studies reviewed on rate of learning in PSI courses used achievement as the basic criterion measure when comparing outcomes in teacher-paced versus self-paced instruction. However, no studies were found that investigated the interaction of student cognitive style and method of instruction to overall achievement.

Summary of the Research

To meet the needs of new students currently enrolled in postsecondary institutions, instructional systems involving modular courses, self-paced learning and other technologies have been developed. A number of studies indicate that these individualized instructional systems produce significantly more positive student attitudes toward a course and higher achievement when compared to the traditional lecture format (Mielke & Hill, 1977; Jernstedt, 1976; Kulik, & Smith, 1976). However, while all of these individualized instructional systems appear to be effective for some students in a variety of settings, there is no clear

evidence in the literature to establish superiority of one instructional method over another as the best individualizing procedure (Shalock, 1976, p. 48).

In response to the need for more effective teaching methods, a number of postsecondary instructors have experimented with PSI. Research findings on PSI indicate that it is effective in improving both students' attitudes toward a course as well as their performance on a variety of course achievement indicators when compared with students taught by a traditional approach (Kulik, Kulik & Carmichael, 1974).

Research findings indicate that self-pacing is often associated with high withdrawal rates and procrastination. Instructor-paced approaches have been used to counteract problems associated with procrastination and high withdrawal rates. Research findings support the premise that deadline and positive incentive systems can result in evenly distributed rates of unit completion and significantly lower withdrawal rates (Morris, Surber & Bijou, 1978; Reiser & Sullivan, 1977; Robin, 1976). Data on achievement, however, indicates no statistically significant difference between self-paced and instructor-paced groups (Reiser & Sullivan, 1977; Burt, 1975; Bitgood & Segrave, 1975). Research findings indicate that mean attitude survey scores do not differ significantly between the two treatment groups (Reiser & Sullivan, 1977).

Research has been found to support the premise that cognitive style and achievement are related (Horak, 1978; Marchese, 1978; Witkin et al., 1977; Renzi, 1974). Research findings also support the premise that field-dependence-independence and different methods of instruction are related in terms of student achievement (Witkin et al., 1977).

The goal of this study is to further the research on the effects of field-dependence-independence and method of instruction on achievement and attitude. It is anticipated that the results of this study will significantly contribute to educational experimentation at the researcher's own institution. It will also provide additional research, knowledge, and perhaps a partial solution to the problems of pacing and student achievement in individualized instructional programs.

CHAPTER III

METHODOLOGY

Population and Selection of the Sample

Throughout history, many predominantly Black colleges and universities have faced the challenge of providing educational opportunities for students who have gained access to higher education through open admissions. A number of these students are low achievers who do not possess the same aptitudes and personality characteristics of traditional college students. Within the last decade many predominantly Black postsecondary institutions (in cooperation with the Institute for Services to Education) have developed instructional programs designed to meet the needs of these students in terms of their differing aptitudes and learning rates.

The Institute for Services to Education (ISE) is an organization that has assisted many Black colleges and universities in developing instructional programs for effective teaching and learning. ISE, incorporated in 1965 as a non-profit organization funded by a grant from the Carnegie Corporation of New York, was founded on the principle that education today requires a fresh examination of what to teach and how to teach it. Based on this principle, ISE undertakes a variety of educational tasks in working with disadvantaged youth and Black youth in educational settings both in predominantly Black and predominantly white postsecondary institutions.

From 1967 to the present, ISE has been working cooperatively with the Thirteen-College Consortium in developing the Thirteen-College

Curriculum Program which is designed to produce new and pertinent educational changes within the consortium institutions. Norfolk State University is one of the thirteen colleges participating in the program. Since Norfolk State utilizes an individualized instructional approach in its basic freshmen-level mathematics courses, it was chosen for this study.

Norfolk State is a predominantly Black "open door" urban school comprised mostly of commuting students. The typical student who enrolls is deficient in basic skills such as reading, writing, and arithmetic. Many of these students have passive attitudes toward learning and exhibit a low level of self-confidence. The Individually Prescribed Mathematics Instruction Program (IPMIP) provides an opportunity for these students to progress through prescribed course content at their own pace.

Instruments

To conduct this study, it was necessary to select appropriate instruments to 1) assess the cognitive style of students involved, 2) measure mathematical achievement of students involved, and 3) measure attitudes toward mathematics. Selected instruments included The Group Embedded Figures Test (Oltman, Raskin & Witkin, 1971), California Achievement Tests - Mathematics, Level 19, Form C (CTB/McGraw-Hill, 1978), and the Aiken Revised Math Attitude Scale (Aiken, 1974).

Group Embedded Figures Test (GEFT). The Embedded Figures Test (EFT) developed by Witkin and his associates represents an approach to the measurement of cognitive style based on the study of perception. On the EFT the subject is required to recognize a geometric figure

within a complex background. For some people, the sought-after simple figure is easily identified in the complex design; others are not able to find it in the three minutes allowed for search. The former persons are designated "field-independent", whereas the latter are "field-dependent."

A Group Embedded Figures Test, a version of the EFT, is also available for group administration. The manual (Witkin et al., 1971, pp. 27-28) for the GEFT indicates a reliability estimate of .82 for the test. A high correlation has been found between scores on the GEFT and the EFT, with male undergraduates having a correlation of .82 and female undergraduates having a correlation of .63.

Although the GEFT was shown by Witkin et al., (1971) to relate to other measures of field-dependence, the authors point out a need for additional validity studies for this instrument. This suggestion is consistent with the findings of a study by Renna and Zenhausern (1976) where a sample of three-hundred and thirty-seven undergraduates was found to be more field-dependent than expected on the basis of Witkin et al.'s (1971) norms. Evan (1978) showed that correlations between the EFT and an early version of the GEFT were higher when subjects had prior opportunity to practice the group task. For sixty-two inexperienced college students, the correlation was .41; for forty-three experienced subjects, the correlation increased to .73.

California Achievement Test. The decisive factor in selecting this test was that the content of the test was directly related to the mathematical content of this study.

The CAT is a multiple choice test designed to measure achievement in the basics of any instructional program: prereading or reading,

spelling, language, and mathematics. The Mathematics Computation Test Six (25 minutes), contains fundamental-operation exercises on whole numbers, fractions, decimals, per cent, and ratio. A student's achievement measure in this study was his raw score total.

The instrument possesses a satisfactory split-half reliability coefficient for each of its normed sections. The test is also available commercially.

Math Attitude Scale. Paragraphs describing attitudes toward mathematics written by 310 college students were reduced to scaled items according to Likert's procedure to formulate the basis for the Math Attitude Scale (Aiken, L. R., & Dreger, R. M. 1961). The final scale consisted of 10 items connoting negative attitudes and 10 connoting positive.

Preliminary investigation using this scale attested to its reliability ($r = .94$ for test-retest). In addition, a test of independence between the scores on the attitude scale and scores on four items designed to measure attitude toward academic subjects in general suggested that attitudes specific to mathematics were being measured ($\chi^2 = 80$, $df = 1$).

Subjects

Three hundred eighteen prospective students were administered the Group Embedded Figures Test during the freshman orientation period prior to the 1980 fall semester at Norfolk State University.

The subjects for this study consisted of those students enrolled in Mathematics in General Education who were classified as field-dependent or field-independent on the basis of their performance on the Group

Embedded Figures Test. The field-independent subject was defined as an individual who scored above the mean on the Second and Third sections of the GEFT. The field-dependent subject was defined as an individual who scored below the mean on the same two sections. The thirty-four most field-independent students and the thirty-four most field-dependent students were identified and assigned at random to two classes of basic mathematics taught at the same time of the day on the basis of seventeen field-independent and seventeen field-dependent students per class. The results of this procedure appear below in Table 3.1.

TABLE 3.1 STRUCTURE OF CLASSES

		Cognitive Style		
		Dependent	Independent	
Treatment	Instructor-paced	17	17	34
	Self-paced	17	17	34
	Total	34	34	68

Two teachers were then assigned to these classes. One teacher was experienced in and had expressed a preference for a teacher-structured method of teaching while the other was experienced in and had expressed a preference for a student-structured method of teaching.

All subjects completed a Consent Form granting permission for use of collected data and other demographic information. Specific information concerning the design and purpose of the study was not discussed in detail.

Procedures

The experimental phase of the course was delayed for two and one-half weeks in order to familiarize students with the Individually Prescribed Mathematics Instruction Program (IPMIP). During this period of delay, a

variety of basic mathematics topics were discussed. At the end of this period, a unit of study on fractions, decimals, and per cents was begun in both classes. All procedures except the pacing procedure were identical for the two groups. Students in both groups used identical materials. Materials used in IPMIP are called Learning Packages (LP). The packages are basically self-instructional modules that focus on five to ten well-defined behavioral objectives. The substance of each module consists of activities and instructions necessary to accomplish the stated objectives.

The modules used in this study were evaluated by a team of Learning System Designers at Norfolk State University as part of a program sponsored by the Institute for Services to Education (ISE). All modules were rewritten based on the team's recommendations. Each module contains behavioral objectives and is accompanied by eight forms of a quiz keyed to these objectives. The final form of each quiz consists of short response items.

Students obtained each learning package from the Mathematics Reinforcement Center and was allowed to use it for no more than 48 hours. The student could seek help from tutors and/or the instructor as he progressed through the module. When he felt that he was ready to take the module post-test, he would go to the Mathematics Testing Center where he was administered the post-test for the particular module he had studied.

Short quizzes, approximately fifteen items each, were used to assess student mastery of the material in each module. Lab technicians, serving as proctors, graded and reviewed the quizzes with the students. A mastery requirement was stipulated for each module. If a student scored below the

mastery level, he was required, after reviewing the materials, to take other forms of the quiz until the specified level of mastery was attained.

Each student's final grade for the unit was determined by the total number of quizzes passed by that student. Students were required to pass at least twelve of the sixteen module quizzes to be eligible for a passing grade: 16 units = A, 15 units = B, 13-14 units = C, 12 units = D, and 11 units or less = F.

Self-paced students were permitted to take the quizzes at their own rate within a 12-week experimental period. Teacher-paced students took the quizzes for the assigned modules according to a course calendar, covering the 12-week period.

The mathematical content covered in the learning packages appears as Appendix A. The course calendar appears as Appendix B.

Data was collected and analyzed on 1) student achievement as measured by the number of module quizzes passed, 2) student achievement as measured by scores on an achievement test and 3) attitudes toward the course.

Statistical Hypotheses

In order to test the research hypotheses previously formulated, the following statistical hypotheses were made:

1. (H_0): There is no significant difference in withdrawal rates between students in the self-paced group and students in the instructor-paced group.
2. (H_0): There is no significant difference in withdrawal rates between field-dependent students and field-independent students.
3. (H_0): There is no significant interaction in withdrawal rates between students grouped according to cognitive style and students grouped according to treatment.
4. (H_0): There is no significant difference in achievement as measured by number of module quizzes passed between students in the instructor-paced group and students in the self-paced group.

5. (H_0): There is no significant difference in achievement as measured by number of module quizzes passed between field-dependent students and field-independent students.
6. (H_0): There is no significant interaction between students grouped according to cognitive style and students grouped according to treatment on achievement as measured by number of module quizzes passed.
7. (H_0): There is no significant difference in achievement as measured by post-test score between students in the instructor-paced group and students in the self-paced group.
8. (H_0): There is no significant difference in achievement as measured by post-test score between field-dependent students and field-independent students.
9. (H_0): There is no significant interaction between students grouped according to cognitive style and students grouped according to treatment on achievement as measured by post-test score.
10. (H_0): There is no significant difference in attitude between students in the self-paced group and students in the instructor-paced group.
11. (H_0): There is no significant difference in attitude between field-dependent students and field-independent students.
12. (H_0): There is no significant interaction in attitude between students grouped according to cognitive style and students grouped according to treatment.
13. (H_0): There is no significant difference in pacing rates between students in the instructor-paced group and students in the self-paced group.
14. (H_0): There is no significant difference in pacing rates between field-dependent students and field-independent students.
15. (H_0): There is no significant interaction in pacing rates between students grouped according to cognitive style and students grouped according to treatment.

Statistical Tests

A Posttest Only 2x2 factorial design was used in this study with teaching method (instructor-paced and self-paced) as one variable and cognitive style (field-dependent and field-independent) as the other.

Hypotheses one, two, thirteen and fourteen were tested by means of the chi square statistic. This test helps to determine whether a systematic relationship exists between two variables. This is done by computing the cell frequencies which would be expected if no relationship is present between the variables given the existing row and column totals. The expected cell frequencies are then compared to the actual values found in the table according to the following formula:

$$\chi^2 = \sum \frac{(|a - e| - 0.5)^2}{e}$$

(corrected for continuity)

a represents the actual frequency of an event, and

e represents the expected frequency.

Hypotheses three, four through twelve, and fifteen were tested by means of analysis of variance. This statistic is used to determine whether the difference in sample means are due to chance only and therefore are not significant. It also determines the interaction effect between the factors involved.

This procedure achieves its goal by comparing sample variances. The ratio between the variation explained by treatments and the error or unexplained variation is used as a basis of comparison and is computed using the following formula:

$$F = \frac{SS_A / (K - 1)}{SS_{error} / (N - K)} = \frac{MS_A}{MS_{error}}$$

with $(K - 1)$ and $(N - K)$ degrees of freedom, where

SS_A often referred to as SS_{between} , estimates the variation between sample means;

SS_{error} estimates the variation within each of the samples;

K represents the number of samples; and

N represents the total number of subjects involved in the study.

CHAPTER IV

FINDINGS

In the analysis of the data, all hypotheses tested statistically by chi square and analysis of variance were accepted at the .05 level of significance. (Results significant at the .01 level were reported as such).

Data for hypotheses one through three and thirteen through fifteen were computed on the basis of all students who participated in the program, whether they withdrew or not prior to the end of the experimental period (Table 3.1, Chapter III). Data for hypotheses four through twelve were computed on the basis of mean scores of students who completed the IPMIP (See Table 4.1). Each of the hypotheses is discussed below.

TABLE 4.1 NUMBER OF STUDENTS COMPLETING THE PROGRAM

		Cognitive Style		
		Dependent	Independent	
TREATMENT	Instructor-paced	9	12	21
	Self-paced	3	8	11
	Totals	12	20	32

Hypothesis 1, There is no significant difference in withdrawal rate between students in the self-paced group and students in the instructor-paced group.

This hypothesis was tested by means of chi square on the basis of the data presented in Table 4.2

TABLE 4.2 WITHDRAWAL RATE BY TREATMENT

	Completed	Withdrew	Total
Instructor-paced	16 21	18 13	34
Self-paced	16 11	18 23	34
Total	32	36	68

$$\chi^2 = 4.78, df = 1, p < .05$$

Since the actual χ^2 of 4.78 exceeded the expected χ^2 of 3.84, the hypotheses was rejected. The test indicated that the difference in withdrawal rate between the self-paced group and the instructor-paced group was statistically significant.

Hypothesis 2, There is no significant difference in withdrawal rate between field-dependent students and field-independent students.

The hypothesis was tested by means of chi square using the data presented in Table 4.3.*

Since the actual χ^2 of 2.89 did not equal or exceed the expected χ^2 of 3.84, the hypothesis was not rejected. The test indicated that there was no significant difference in withdrawal rate between field-independent and field-dependent students.

*NOTE: See page 65 for Table 4.3.

Hypothesis 3. There is no significant interaction in withdrawal rate between students grouped according to cognitive style and students grouped according to treatment.

From an analysis of variance (Table 4.4), when 1 and 64 degrees of freedom was used a value of .260 was not significant. The hypothesis was not rejected. The test indicated that there was no significant interaction between students grouped according to cognitive style and students grouped according to treatment in terms of withdrawal rate.

TABLE 4.4 ANALYSIS OF VARIANCE ON THE BASIS OF COGNITIVE STYLE

Source of Variation	S.S.	d.f.	M.S.	F
A (Groups)	1.471	1	1.471	6.504
B (Cognitive Style)	.941	1	.941	4.163
A x B	.059	1	.059	.260
Residual	14.471	64	.226	
Total		67		

Hypothesis 4. There is no significant difference in achievement as measured by mean number of module quizzes passed between students in the instructor-paced group and students in the self-paced group.

From an analysis of variance (Table 4.5), when 1 and 28 degrees of freedom was used, a value of 9.884 was significant. The hypothesis was rejected. The test indicated that the difference between mean scores as measured by number of module quizzes passed was statistically significant.

TABLE 4.5 ANALYSIS OF VARIANCE ON THE BASIS OF ACHIEVEMENT BY NUMBER OF MODULE QUIZZES PASSED

Source of Variation	S.S.	d.f.	M.S.	F
A (Groups)	16.698	1	16.698	9.884**
B (Cognitive Style)	22.797	1	22.797	13.493**
A x B	21.863	1	21.863	12.941**
Residual	47.305	28	1.689	
Total		31		

** F is significant at the .01 level

Hypothesis 5. There is no significant difference in achievement as measured by mean number of module quizzes passed between field-dependent students and field-independent students.

From an analysis of variance (Table 4.5) using 1 and 28 degrees of freedom, a value of 13.493 was significant. The hypothesis was rejected. The test indicated the difference between mean scores as measured by number of module quizzes passed was statistically significant.

Hypothesis 6. There is no significant interaction between students grouped according to cognitive style and students grouped according to treatment on achievement as measured by mean number of module quizzes passed.

From an analysis of variance (Table 4.5), when 1 and 28 degrees of freedom was used, a value of 12.941 was significant. The hypothesis was rejected. The test indicated that the interaction between students grouped according to cognitive style and students grouped according to treatment on mean score as measured by number of module quizzes passed was statistically significant.

Hypothesis 7. There is no significant difference in achievement as measured by mean posttest score between students on the instructor-paced group and students in the self-paced group.

From an analysis of variance (Table 4.6), when 1 and 28 degrees of freedom was used, a value of 1.312 was not significant. The hypothesis was not rejected. The test indicated that there was no significant difference in achievement as measured by mean posttest score between the instructor-paced group and the self-paced group.

TABLE 4.6 ANALYSIS OF VARIANCE ON THE BASIS OF POSTTEST SCORE

Source of Variation	S.S.	d.f.	M.S.	F
A (Groups)	36.312	1	36.312	1.312
B (Cognitive Style)	73.780	1	73.780	2.667
A x B	22.674	1	22.674	.820
Residual	774.680	28	27.667	
Total		31		

Hypothesis 8. There is no significant difference in achievement as measured by mean posttest score between the field-dependent students and the field-independent students.

From an analysis of variance (Table 4.6), when 1 and 28 degrees of freedom was used, a value of 2.667 was not significant. The hypothesis was not rejected. The test indicated that there was no significant difference in achievement as measured by mean posttest score between the field-dependent students and the field-independent students.

Hypothesis 9. There is no significant interaction between students grouped according to cognitive style and students grouped according to treatment on achievement as measured by posttest score.

From an analysis of variance (Table 4.6), when 1 and 28 degrees of freedom was used, a value of .820 was not significant. The hypothesis was not rejected. The test indicated that there was no significant interaction between students grouped according to cognitive style and students grouped according to treatment on achievement as measured by posttest score.

Hypothesis 10. There is no significant difference in attitude between students in the self-paced group and students in the instructor-paced group.

From an analysis of variance (Table 4.7), when 1 and 28 degrees of freedom was used, a value of .823 was not significant. The hypothesis was not rejected. The test indicated that there was no significant difference in attitude between students in the self-paced group and students in the instructor-paced group.

TABLE 4.7 ANALYSIS OF VARIANCE ON THE BASIS OF ATTITUDE

Source of Variation..	S.S.	d.f.	M.S.	F
A (Groups)	121.772	1	121.772	.823
B (Cognitive Style)	692.508	1	692.508	4.678*
A x B	633.362	1	633.362	4.279*
Residual	4144.660	28	148.024	
Total		31		

* F is significant beyond the .05 level

Hypothesis 11. There is no significant difference in attitude between field-dependent students and field-independent students.

From an analysis of variance (Table 4.7), when 1 and 28 degrees of freedom was used, a value of 4.678 was significant. The hypothesis was rejected. The test indicated that the difference in attitude between field-dependent and field-independent students was statistically significant.

Hypothesis 12. There is no significant interaction in attitude between students grouped according to cognitive style and students grouped according to treatment.

From an analysis of variance (Table 4.7), when 1 and 28 degrees of freedom was used, a value of 4.279 was significant. The hypothesis was rejected. The test indicated that the interaction in attitude between students grouped according to cognitive style and students grouped according to treatment was statistically significant.

Hypothesis 13. There is no significant difference in pacing rate between students in the instructor-paced group and students in the self-paced group.

The hypothesis was tested by means of chi square on the basis of the data presented in Table 4.8.

TABLE 4.8 PACING RATE BY TREATMENT

	Steady Pace	Unsteady Pace	Total
Instructor-paced	18.5 21	20.5 13	34
Self-paced	18.5 6	20.5 28	34
Total	37	41	68

$$\chi^2 = 12.04, df = 1, p < .001$$

Since the actual χ^2 of 12.04 exceeded the expected χ^2 of 3.84, the hypothesis was rejected. The test indicated that there was a significant difference in pacing rate between students in the instructor-paced group and students in the self-paced group.

Hypothesis 14. There is no significant difference in pacing rate between field-dependent students and field-independent students.

The hypothesis was tested by means of chi square on the basis of the data presented in Table 4.9.

TABLE 4.9 PACING RATE BY COGNITIVE STYLE

	Steady Pace	Unsteady Pace	Total
Field- Independent	13.5 18	20.5 16	34
Field- Dependent	13.5 9	20.5 25	34
Total	27	41	68

$$\chi^2 = 3.93, df = 1, p < .05$$

Since the actual χ^2 of 3.93 exceeded the expected χ^2 of 3.84, the hypothesis was rejected. The test indicated that there was a significant difference in pacing rate between field-dependent and field-independent students.

Hypothesis 15. There is no significant interaction in pacing rate between students grouped according to cognitive style and students grouped according to treatment.

From an analysis of variance (Table 4.10), when 1 and 64 degrees of freedom was used, a value of .397 was not significant. The hypothesis was not rejected. The test indicated that there was no significant

interaction in pacing rate between students grouped according to cognitive style and students grouped according to treatment.

TABLE 4.10 ANALYSIS OF VARIANCE ON THE BASIS OF TREATMENT

Source of Variation	S.S.	d.f.	M.S.	F
A (Groups)	3,309	1	3,309	.000
B (Cognitive Style)	1,191	1	1,191	.013
A x B	.132	1	.132	.397
Residual	11,647	64	.182	
Total		67		

TABLE 4.3 WITHDRAWAL RATE BY COGNITIVE STYLE

	Completed	Withdrew	
Field-Independent	16 20	18 14	34
Field-Dependent	16 12	18 22	34
	32	36	68

$$\chi^2 = 2.89, df = 1, p < .089$$

Summary of Findings

Within the limits of this study and for the population of the study, statistically significant differences were found in the following areas:

1. There was a significant difference in withdrawal rate between the self-paced group and the instructor-paced group ($p < .05$).
 2. There was a significant difference between mean scores as measured by number of module quizzes passed between students in the instructor-paced group and students in the self-paced group ($p < .01$).
 3. There was a significant difference between mean scores as measured by number of module quizzes passed between field-dependent students and field-independent students ($p < .01$).
 4. There was a significant interaction between students grouped according to cognitive style and students grouped according to treatment in terms of number of module quizzes passed ($p < .01$).
 5. There was a significant difference in attitude between field-dependent and field-independent students ($p < .05$).
 6. There was a significant interaction between students grouped according to cognitive style and students grouped according to treatment in terms of attitude ($p < .05$).
 7. There was a significant difference in pacing rate between students in the instructor-paced group and students in the self-paced group ($p < .001$).
 8. There was a significant difference in pacing rate between field-dependent students and field-independent students ($p < .05$).
- Within the limits of this study and for the population of the study, statistically significant differences were not found in the following areas:

1. There was no significant difference in withdrawal rate between field-independent and field-dependent students.

2. There was no significant interaction between students grouped according to cognitive style and students grouped according to treatment in terms of withdrawal rate.

3. There was no significant difference in achievement as measured by mean posttest score between students in the instructor-paced group and students in the self-paced group.

4. There was no significant difference in achievement as measured by mean posttest score between field-dependent students and field-independent students.

5. There was no significant interaction between students grouped according to cognitive style and students grouped according to treatment in terms of mean posttest score.

6. There was no significant difference in attitude between students in the self-paced group and students in the instructor-paced group.

7. There was no significant interaction between students grouped according to cognitive style and students grouped according to treatment in terms of pacing rate.

CHAPTER V

SUMMARY AND CONCLUSIONS

To meet the needs of new students currently enrolled in post-secondary institutions, instructional systems involving modular courses, self-paced learning, and other technologies have been developed. A number of studies indicate that these individualized instructional systems produce significantly more positive student attitudes toward a course and higher achievement when compared to the traditional lecture format (Jernstedt, 1976; Kulik, Kulik, & Smith, 1976; Mielke & Hill, 1977). However, while all of these individualized instructional systems appear to be effective for some students in a variety of settings, there is no clear evidence in the literature to establish superiority of one instructional method over another as the best individualizing procedure (Shalock, 1976, p. 48).

In response to the need for more effective teaching methods, a number of postsecondary instructors have experimented with The Personalized System of Instruction (PSI). Research findings on PSI indicate that it is effective in improving both students' attitudes toward a course as well as their performance on a variety of course achievement indicators when compared with students taught by a traditional approach (Kulik, Kulik & Carmichael, 1974).

Although the general findings on the effectiveness of PSI are favorable, the withdrawal rate from PSI courses is often very high. This might be due to the self-pacing feature of PSI courses which has produced student procrastination and high withdrawal rates. Researchers have

sought to improve pacing and resolve the problems of high withdrawal rate by implementing instructor-paced schedules in place of student self-pacing in several PSI courses. Results of these studies indicate that although instructor-pacing modifies student procrastination and withdrawal rate, it does not appear to influence academic achievement.

One potential problem with most PSI investigations is that they fail to relate performance in PSI courses to learner traits and aptitudes. As a result, they may conceal the presence of interactions between distinct learner traits, on the one hand, and alternative instructional treatments, on the other (Pascarella, 1974, p. 1). Instructor-pacing may be more effective for one type of student while self-pacing may be appropriate for the achievement of a different type of student.

The above considerations raise serious questions about the "one best way" approach to instructional improvement. Kozma (1978, p. 9) points out that limiting the instructional question to "best method" ignores the uniqueness of the learner. Researchers now agree that the underlying question should be "What methods are best for what students and under what conditions?" (Cross, 1976, p. 111; Davis, 1976, p. 10; Kozma, 1978, p. 7).

In approaching this problem of understanding which students learn best under what conditions, recent instructional research has considered another approach to individualization. Whereas the "one best way" approach deals only with the methods or treatments of instruction, this new research includes a second element: the student. This approach to individualization focuses on the characteristics (aptitudes) of each student and attempts to match instruction to the needs of individual learners.

This trend of matching instruction to the needs of individual learners has led to an extensive search for influential individual difference variables. One such variable which might be related to the effectiveness of an instructor-paced or a self-paced method of instruction is cognitive style.

One of the most widely researched models of cognitive style is the field-dependence-independence dimension studied extensively by Witkin, et al, (1974, 1977). Research on the cognitive and personal characteristics associated with field dependence-independence has produced findings that may have implications for education. In an extensive review, Witkin (1976, p. 57) noted that a student's cognitive style may influence his or her way of learning, and that the extent of matches or mismatches on field-dependence-independence has significant implications for the learning process.

The literature also supports the contention that the field-independent student is more likely to achieve success with self-pacing, an unstructured approach, than is the field-dependent student (Douglass & Kahle, 1978; McLeod et al., 1978; Renzi, 1974; Witkin & Moore, 1974). Even though students give self-pacing top ranking among course features contributing to their enjoyment of learning (Nelson & Scott, 1974) and the majority indicate that the burdens of self-pacing are not frustrating (Hoberock & others, 1974), research indicates that with no specific deadlines, many students procrastinate. These procrastinators may be field-dependents whose needs are not being met in a self-paced situation. Instructor-paced approaches, then, should suit the needs of these relatively field-dependent students who prefer clear directions and instructor responsibility, and who also experience difficulty in organizing their own learning materials.

The purpose of this study was to investigate the effects of two alternative instructional strategies for students of differing cognitive styles on academic achievement and attitude in a basic mathematics course. The two instructional strategies were self-paced and instructor-paced, while the two cognitive styles were field-dependent and field-independent.

The sample for this study consisted of 318 students enrolled in Mathematics in General Education at Norfolk State University during the fall semester, 1980-81. These students were classified as field-dependent or field-independent on the basis of their performance on the Group Embedded Figures Test. The 34 most dependent and 34 most independent students were identified and assigned at random to two classes of basic mathematics taught at the same time of the day on the basis of seventeen field-independent and seventeen field-dependent students per class.

All procedures except the pacing procedure were identical for the two groups. Students in both groups used identical materials referred to as Learning Packages. These packages are basically self-instructional modules that focus on five to ten well-defined behavioral objectives. The substance of each module consists of activities and instructions necessary to accomplish the stated objectives.

Self-paced students were permitted to take module quizzes at their own rate within a 12-week experimental period. Teacher-paced students took the quizzes for the modules according to a course calendar covering the 12-week period.

Data was collected and analyzed on 1) withdrawal rate, 2) student achievement as measured by the number of module quizzes passed, 3) student achievement as measured by scores on an achievement test, 4) attitude

toward the course, and 5) pacing rate. A Posttest Only 2 x 2 factorial design was used in this study with teaching method (instructor-paced and self-paced) as one variable and cognitive style (field-dependent and field-independent) as the other.

Posttests of mathematics attitude and mathematics achievement were administered at the end of the 12-week experimental period. Mathematics attitude was measured by the Aiken Revised Math Attitude Scale, and mathematics achievement was measured by the California Achievement Test (Mathematics, Level 19, Form C). Differences in withdrawal rate and pacing rate were tested by means of the chi square statistic. Differences in achievement and attitude were tested by means of analysis of variance.

Findings

The major findings were as follows:

1. The withdrawal rate of students in the instructor-paced group was significantly lower than that of students in the self-paced group. Thirteen of the 34 students (38%) in the instructor-paced group withdrew, while 23 of the 34 students (68%) in the self-paced group withdrew from the course.
2. There was no significant difference in withdrawal rate between field-independent and field-dependent students.
3. There was no significant interaction between students grouped according to cognitive style and students grouped according to treatment in terms of withdrawal rate.
4. The number of module quizzes passed by students who completed the course differed significantly in favor of the instructor-paced group. All of the instructor-paced students who completed the course and 82% of the self-paced students who completed the course passed at least 12 module quizzes.
5. The number of module quizzes passed by field-independent students was significantly greater than the number of module quizzes passed by field-dependent students. Nineteen of the 20 field-independent students (95%) who completed the course and nine of the 12 field-dependent students (75%) who completed the course passed at least 12 module quizzes.
6. The interaction between cognitive style and achievement as measured by number of module quizzes passed was significantly greater than that between treatment and achievement as measured by the number of module quizzes passed. Students with cognitive styles matched to the cognitive style of the instructional mode performed at a significantly

higher level than those who were nonmatched.

7. There was no significant difference in achievement as measured by mean posttest score between students in the instructor-paced group and students in the self-paced group.

8. There was no significant difference in achievement as measured by mean posttest score between field-dependent students and field-independent students.

9. There was no significant interaction between students grouped according to cognitive style and students grouped according to treatment in terms of mean posttest score.

10. There was no significant difference in attitude between students in the self-paced group and students in the instructor-paced group.

11. The mean attitude score of the field-independent students who completed the course was significantly higher than that of the field-dependent students who completed the course. Mean scores on the 20-item scale were 79.6 for the field-independent group and 70.5 for the field-dependent group.

12. The interaction between cognitive style and attitude was significantly greater than that between treatment and attitude. Students with cognitive styles matched to the cognitive style of the instructional mode exhibited significantly more positive attitudes toward the course than those who were nonmatched. On the other hand, the interaction between method of instruction and attitude did not reach significance.

13. The pacing rate of students in the instructor-paced group was significantly more steady than that of students in the self-paced group. Instructor-paced students maintained a more steady pace in quiz-taking

patterns throughout the experimental period when compared to their self-paced counterparts.

14. The pacing rate of field-independent students was significantly more steady than that of field-dependent students. Field-independent students maintained a more steady pace in quiz-taking patterns throughout the experimental period.

Discussion

One of the major concerns of this study was with the relationship between withdrawal rate and pacing procedures in an individualized instruction program. As hypothesized, a comparison between a student self-paced instructional system and a flexible instructor-paced system revealed that students procrastinated and produced high withdrawal rates when they self-paced, yet proceeded more evenly through course materials when prompted by externally imposed deadlines. In general, these results are in agreement with pacing contingency research (Robin, 1976) as well as research on withdrawal rate (Bijou et al., 1976). The lower withdrawal rate of instructor-paced students in this study was quite likely due to the tendency among these students to exhibit early and consistent involvement in quiz-taking procedures in contrast to their self-paced counterparts. These findings are especially in agreement with those of Reiser and Sullivan (1977) in suggesting that instructor-pacing modifies student procrastination and withdrawal rate.

The relationship between self-pacing and withdrawal rate needs to be examined further. Self-paced courses generally have higher withdrawal rates than instructor-paced courses and the presumption is often made that the self-pacing feature is the cause (Semb et al., 1974). However, it may be that other factors, such as learner traits and aptitudes, are interacting with the self-pacing component, thereby inducing procrastination and high withdrawal rate. As noted previously, Domino (1971) showed how characteristics of the student also can interact with the instructional situation. Had he ignored the student traits of Achievement-Via-Conformance and Independence, Domino's study would have resulted in no significant differences between structured and unstructured teaching

methods. The findings of this study are consistent with Domino's results in that student cognitive styles interacted with the instructional mode to produce high withdrawal rates. In this study, the majority of the students who withdrew were field-dependents enrolled in the self-paced class. Self-pacing allowed each student to proceed through course materials at his own pace, thus assuming responsibility for his own learning. Apparently, some students, especially the field-dependents, were not ready for that responsibility. They procrastinated, exhibited infrequent and sporadic quiz-taking patterns, and failed to complete many modules near the end of the semester. Rather than accept the inevitable low grade or an incomplete, they withdrew from the course. These results lend further support to previous findings that field-dependent people have a greater need for external structuring (Witkin et al., 1977).

On the other hand, field-independent students found self-pacing to be a successful learning experience. One of the reasons for the superiority of the field-independent students in this study may be their preference for assuming responsibility for their own learning. These students could proceed at their own pace with the option of surpassing deadlines in the instructor-paced class. Witkin's theory of cognitive style predicts that field-independent students will perform better when allowed to work independently and the results of the study support this hypothesis.

With regard to achievement, the effects of pacing were more closely tied to the number of module quizzes passed than to posttest scores. The two groups showed a significant difference in the number of module quizzes passed as instructor-paced students passed more module quizzes than their

self-paced counterparts. Just how instructor pacing increased performance is not clear, though one explanation is that imposed deadlines prompted response from students who otherwise may have procrastinated. These potential procrastinators were, perhaps, the field-dependent students who were in the instructor-paced group. Had these students been exposed to self-pacing, they probably would not have realized successful achievement. In other words, students do not self-pace; they pace according to the conditions that control pacing behavior (Bijou et al., 1976); and, if the appropriate conditions are not present in the classroom, pacing should not be expected.

In this study, all of the field-dependents in the instructor-paced class who completed the program passed with a grade of C or better, while none of the field-dependents who completed the course in the self-paced class obtained this level of achievement. Similarly, all but one of the field-independent students in the self-paced class who completed the program passed with a grade of C or better, while all of the field-independents who completed the program in the instructor-paced class passed with a grade of C or better (students in the instructor-paced class could surpass deadlines). These results help confirm the assertions of Cronbach and Snow (1977) that interactions between cognitive style and method of instruction exist in mathematics as in other areas. This confirmation makes an important contribution to the literature on pacing contingencies. The results indicate that measures of cognitive style may be one way to identify the most appropriate pacing contingency for individual students. Self-pacing may be the most important element for some students who learn by working independently, while this approach may not suit the needs and interests of other students who can benefit more from a highly structured

teacher-paced method.

In terms of achievement as measured by posttest score, no significant differences were revealed in this study. These results are also in agreement with other research indicating that whether students self-pace or have their pacing regulated, they score similarly on criterion measures of achievement and do not differ significantly in mean attitude scores (Morris, Surber, and Bijou, 1978; Reiser and Sullivan, 1977; Burt, 1975). It should be noted, however, that the lack of significant differences in achievement may have been caused by the high withdrawal rate in both groups. Data on posttest score was analyzed only for those students who completed the program. Mean posttest score would probably have been significantly higher for the instructor-paced group had all students in both groups been required to take the posttest. This is based on the fact that more students in the instructor-paced group completed the course and were subsequently exposed to more of the course content. Reiser and Sullivan (1977) and Robin (1976) argue similarly.

It is interesting to note that differences in achievement on the criterion measure between field-dependent students and field-independent students support Witkin's theory of cognitive style, although these differences failed to reach significance. Mean scores for the field-dependent students in the instructor-paced class exceeded those of field-dependent students in the self-paced class. Mean scores for field-independent students were approximately the same in both classes. Here again, the failure of these scores to reach significance may be directly related to the high withdrawal rate in both classes.

Data from this study were also consistent with the findings of other research demonstrating that whether students self-pace or have their pacing regulated, they generally demonstrate equally positive attitudes

towards the course (Bitgood & Segrave, 1975; Reiser & Sullivan, 1977). However, when cognitive style was considered, the attitude of field-independent students was significantly more positive than that of field-dependent students. This is understandable since field-independent students more or less controlled their own learning experiences. On the other hand, field-dependent students in the self-paced group were somewhat at a disadvantage since this learning environment is difficult for them. Although the differences did not reach significance, field-dependent students in the instructor-paced group exhibited more positive attitudes than their counterparts in the self-paced group.

Implications

The findings of this study suggest that instructor-pacing, designed to move students through course materials at a uniform rate, is more effective for the majority of students than self-pacing, which allows each student to proceed through course materials at his own pace. This study indicates that when compared to self-pacing students, students in instructor-paced groups produce lower withdrawal rates, maintain a more steady pace in quiz-taking patterns and score higher on measures of achievement. Since instructor-pacing seems to produce steadier quiz-taking patterns, and thereby reducing student withdrawal rates, instructor-pacing should be used more often in individualized instructional programs.

The results of self-pacing in this study are typical of those usually found, especially in regard to student procrastination and high withdrawal rates. Since the self-pacing technique per se does not seem to lead to high withdrawal rates among students, other variables such as learning traits and student cognitive style may be interacting with the self-pacing variable, thereby inducing student procrastination and high withdrawal rates.

It appears that the ability to self-pace with success parallels the degree of field-independence that a student demonstrates. Both the data collected here and that reported elsewhere (Witkin et al., 1977) support this finding. Many researchers, however, maintain that a large number of new students now enrolled in postsecondary institutions are field-dependent (Cross, 1976; Messick, 1976; The Carnegie Commission on Higher Education, 1972) and that they may perform better when they have substantial help and attention from the instructor. It is possible

that for these field-dependent students the burdens of taking full responsibility for their own learning may indeed induce procrastination, high withdrawal rates, failure and negative attitudes. The results of this study indicate that the self-pacing environment is difficult for field-dependents, thus implying that an alternative approach may be more appropriate.

The significant interactions found in this study between cognitive style and alternative instructional strategies have implications for educational practices in providing the optimum learning environment for the student. Assuming that the goals of education include both the maximizing of student achievement levels and student satisfaction, one way of achieving these goals is through matching cognitive style with instructional mode.

A major implication of this study is that instruction should be individualized in such a way that field-dependent students are matched with instructor-pacing and field-independent students are matched with self-pacing instructional modes. These procedures may maximize student success, resulting in more positive attitudes and in higher self-esteem.

It is clear that the interaction between cognitive style and method of instruction is an important dimension which has been seriously neglected by both educational practitioners and researchers. Only by first discovering which student aptitudes are important and how each can be linked effectively to alternative instructional approaches can their relevancy to student achievement and attitude be used in a positive manner.

APPENDIX A
LEARNING PACKAGES UTILIZED FOR
OBTAINING MODULE QUIZ SCORE

LEARNING PACKAGES

1. Understanding Fractions - Part I
2. Understanding Fractions - Part II
3. Equivalent Fractions
4. Finding the Least Common Denominator
5. Addition of Fractions
6. Subtraction of Fractions
7. Multiplication of Fractions
8. Division of Fractions
10. Understanding Decimals - Part I
11. Understanding Decimals - Part II
12. Rounding Decimals
13. Addition and Subtraction of Decimals
14. Division and Multiplication of Decimals
- 14A. Ratio and Proportion
15. Understanding Per Cents - Part I
16. Understanding Per Cents - Part II

APPENDIX B
COURSE CALENDAR UTILIZED BY
INSTRUCTOR-PACED GROUP

COURSE CALENDAR

<u>PACKAGE</u>	<u>COMPLETION DATE</u>	<u>PERIOD</u>
1,2	September 23	1
3		2
4	26	3
5,6	October 3	4
7,8	13	5
10	20	6
11	27	7
12	31	8
13,14	November 7	9
14A	12	10
15	18	11
	December 1	12
	8	13
	11	

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ABSTRACT

THE EFFECT OF PACING AND COGNITIVE STYLE UPON STUDENT ACHIEVEMENT AND ATTITUDE IN BASIC COLLEGE MATHEMATICS

Barbara U. Wilson, Ed.D.

The College of William and Mary in Virginia, June, 1981

Chairman: Professor Clifton F. Conrad

The purpose of this study was to investigate the effects of an interaction between pacing and cognitive style upon student achievement and attitude in a basic mathematics college course. It was hypothesized that student characteristics and alternative teaching methods interact to produce differential effects on academic achievement, withdrawal rate, pacing rate, and attitude. A Posttest Only 2 x 2 factorial design was used in this study with teaching method (instructor-paced and self-paced) as one variable and cognitive style (field-dependent and field-independent) as the other.

The original sample consisted of 318 prospective students who were administered the Group Embedded Figures Test (GEFT). The 34 most field-independent and the 34 most field-dependent students were identified and assigned at random to two classes on the basis of 17 field-independent and 17 field-dependent students per class.

All procedures except the pacing procedures were identical for the two groups. Students in both groups used self-instructional modules that focused on five to ten well-defined behavioral objectives. Self-paced students proceeded at their own rate; whereas, instructor-paced students took module quizzes according to a course calendar covering the 12-week experimental period.

At the end of the experimental period, each student was posttested in achievement, as measured by the California Achievement Test (Mathematics, Level 19, Form C), and attitude, as measured by the Aiken Revised Math Attitude Scale. Differences in achievement and attitude were tested by means of the chi square statistic. All results were reported at the .05 level.

The findings support Witkin's theory of cognitive style. A major implication of this study is that instruction should be individualized in such a way that field-dependent students are matched with instructor-paced and field-independent students are matched with self-paced instructional modes.