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ABSTRACT

The influences of two different instructional techniques--media adjunct programing (MAP) and traditional instructor classroom (TIC) methods--upon several variables were examined. These dependent variables included student learning and retention, state anxiety, state curiosity, time-to-criterion, and student and instructor attitudes. Matched groups of students in an undergraduate pilot training course on weather were randomly assigned to the MAP or TIC treatment. The MAP group completed the course more quickly, averaging a 29% savings in time. Postest and retention test results showed no significant differences between groups. The MAP students showed lower state anxiety and reported more positive attitudes toward their instructional method. Predictions of an inverse relation between state curiosity and state anxiety were only partially supported. It was concluded that the individualized, self-paced, multimediated MAP treatment was both effective and feasible, since students receiving it learned faster, had lower state anxiety, better motivation and more positive attitudes. Individualization of subsequent courses was recommended so that students who finished early would be able to continue at an accelerated pace. (PB)

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MEDIA ADJUNCT PROGRAMMING: AN INDIVIDUALIZED MEDIA-MANAGED APPROACH TO ACADEMIC PILOT TRAINING

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Media Adjunct Programming: An Individualized Media-Managed Approach to Academic Pilot Training

EXECUTIVE SUMMARY

INTRODUCTION:

The present study sought to apply the principles of educational technology to a representative undergraduate pilot training (UPT) academic course and utilize a variety of multimedia hardware, in an effort to reduce academic training time while improving motivation retention for students differing in levels of trait curiosity, trait anxiety, and prior knowledge of course content.

APPROACH:

The effectiveness of the multimedia approach to instruction is predicated on the assumption that well-planned and tested combinations of media teach more effectively than a single medium due to differential characteristics of the media, learning task, and learner. Combine the multimedia approach, which is primarily concerned with student motivation, with the concept of individualized instruction, which adapts the pace of instruction to student's ability, and the resultant course should increase student motivation and retention of learning while reducing training time requirements.

An individual difference variable of importance for optimal learning is the student's internal motivation (demonstrated by his level of curiosity) toward the learning task. Evidence from a variety of sources suggests that curiosity behaviors enhance the processing of new information (e.g., Berlyne, 1960, 1967, 1971; Charlesworth, 1969; Day, 1967, 1969). Another individual difference variable, anxiety, has been identified as important because it is detrimental to both the arousal of curiosity behaviors and optimal performance within a learning task. For these reasons, well-structured instructional programs which stimulate curiosity and reduce the adverse effects of anxiety should facilitate student performance on the learning task. To fully assess the effects of instructional treatments in this study, it was deemed desirable to take both trait and state curiosity and trait and state anxiety measures.

An instructional treatment which has been identified as an efficient and effective self-instructional technique is adjunct programming (Pressey, 1967; Rothkopf, 1966, 1968; Frase, 1967). This technique generally refers to the utilization of printed instructional materials in conjunction with an accessory program which questions the student over the material, gives him practice in identifying and memorizing important information and provides a means of identifying areas of student difficulty which require remediation or additional study.

In order to fully exploit the potential of adjunct programming within UPT, the present study sought to combine the efficiency of adjunct questions with the versatility of multimedia presentations. This combined concept was entitled Media Adjunct Programming (MAP), which also was extended to include the concept of self-paced individualized instructional management via the adjunct media software and hardware.

METHOD:

Adjunct questions over the course units were presented via a modified random access projector which provided a record of student performance and readiness for the next instructional unit. Instructional software in the form of MAP guides provided the student with the course outline, placement of adjunct questions within the course, and routed him to the various media devices for presenting each course module.

The UPT academic course covering the basic principles of weather was chosen as representative subject matter for applying the MAP approach. Existing course instructional materials and test items were modified as required for presentation on two tape/slide media devices and a motion picture media device. Principles of educational technology were applied to course development and media selection.

The experimental design was basically a pretest-posttest type design in which UPT students were randomly assigned to the MAP or traditional instructor-classroom (TIC) groups on the basis of their entering knowledge of course training objectives, their trait anxiety, and their trait curiosity.

RESULTS:

The hypothesis that students in the MAP group would complete the course in less time and perform equally as well on posttest and retention tests as students in the TIC group, was confirmed. Students in the MAP group were found to complete the weather course in 29% less time than students in the TIC group. In addition, the differences in performance of the MAP and TIC groups in the posttest and retention tests were not significant. The performance of students in both groups decreased from posttest to retention test. MAP and TIC groups were comparable in overall levels of state curiosity (or interest) in the weather materials; however, students in the MAP group reported lower levels of state anxiety while learning than students in the TIC groups. Predictions of an inverse relationship between state curiosity and state anxiety were only partially supported, in that significant interactions were found between treatment conditions and subject groups. It was found also that students in the MAP group had significantly higher attitudes toward the instructional method. Additionally, the attitudes of the two ATC weather course instructors toward the MAP method of instruction were generally positive.

CONCLUSIONS:

The present study supported the major hypothesis of reduced training time and comparable performance on the posttest and retention test for students in the MAP condition relative to the TIC condition. The advantages of the multimedia, individualized training are suggested by the findings of lower state anxiety and higher attitudes for MAP than TIC students. The positive attitudes of both UPT students and instructors toward the MAP method indicates the feasibility of this approach for enhancing academic UPT. It should be noted, however, that the efficiency of the MAP approach is manifest in terms of time. A student who finishes "early" has not benefited unless he is permitted to continue this accelerated pace. This study indicates that the individualized approach to all of UPT academics is feasible and would exploit fully the advantages demonstrated by this research.

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1. INTRODUCTION

1.1 Nature of the problem. The present study sought to (a) extend the principles of educational technology and individualized instructional management to a representative academic undergraduate pilot training (UPT) course, and (b) utilize a variety of multi-media hardware available at the Williams AFB learning center, in an effort to (c) reduce academic training time and improve motivation and retention for students differing in levels of trait curiosity, trait anxiety, and prior knowledge of course content. The importance of this research relates to the need to optimize multi-media training systems for UPT and to investigate the role of individual difference variables in this optimization process.

Researchers have recently recognized the efficiency of applying multi-media instructional techniques to the undergraduate pilot training of airborne skills (Anderson and Hagin, 1971; Wood, 1971). The advantages of multi-media instructional techniques are not only recognized in terms of improved student performance, motivation, and learning rates, but also in terms of improved opportunity for instructor involvement in individualized instructional principles. The principles of individualized instruction include a concern with optimal (1) student motivation and interest in the learning materials; (2) kinds and difficulty levels of the materials or instructional methods; (3) adaptations to individual differences; (4) scheduling and pacing of instruction; and (5) shift from instructional program control to self-regulated learning activities (Carpenter, 1971). Furthermore, inherent in the use of multi-media instructional techniques is an emphasis on the systems approach to training, which involves the specification of task components as behavioral objectives toward which students are efficiently trained. The effectiveness of the multi-media approach, therefore, is predicated on the assumption that well-planned and tested combinations of media teach more effectively than a single medium, due to differential media characteristics, learning task characteristics, and learner characteristics (e.g., Bretz, 1971).

Application of multi-media techniques to the training of academic concepts and principles related to future task performance has generally indicated the superiority of multi-media presentations compared to instructor-classroom presentations for reducing the effects of individual differences on student performance in a variety of training programs (e.g., Federico, 1971; Folley, Woods, and Foley, 1967; Whitted, Weaver, and Foley, 1966). Individual difference variables which can influence how much is learned include (a) curiosity toward the subject matter during learning, (b) anxiety aroused either by the subject matter or the instructional treatments during learning, and (c) attitude toward the learning environment or instructional method.

An individual difference variable of primary importance for optimal learning is the student's internal motivation (or his level of curiosity) toward the learning task. Evidence from a variety of sources suggests that curiosity behaviors enhance the acquisition of knowledge and processing of new information (e.g., Berlyne, 1960, 1967, 1971; Charlesworth, 1969; Day 1967, 1969). In addition, the type of curiosity most relevant to the learning process is epistemic or knowledge-seeking curiosity. Epistemic curiosity is related to thinking and problem-solving and can lead to permanent storage of information (Berlyne, 1960, 1971).

Another individual difference variable which has been identified as detrimental to both the arousal of curiosity behaviors and optimal performance within a learning task is anxiety (Day, 1967, 1969; Lester, 1968; Leherissey, 1971, 1972). Anxiety interferes with a variety of cognitive and mediational processes, increases the student's need for positive reinforcement and individual attention, and generally produces a greater need for structured instruction (Phillips, Martin, and Mayer, 1969). For this reason, well-structured instructional programs which stimulate curiosity and provide constructive individual feedback and media flexibility can reduce both anxiety and the adverse effects of anxiety on performance.

Recent research in the area of personality processes and learning has pointed out the necessity for distinguishing between personality traits and states (e.g., Day, 1969; Spielberger, 1966). Whereas traits imply relatively stable personality predispositions, states imply transitory emotional conditions which fluctuate over time as a function of situational factors. Of particular relevance to the present study are the findings that states of both curiosity and anxiety are more closely related to student performance in a variety of learning situations than their trait counterparts (McCombs, Eschenbrenner, and O'Neil, 1973; Leherissey, O'Neil, Heinrich, and Hansen, in press; Leherissey, O'Neil, and Hansen, 1971). Furthermore, it has been demonstrated that traits of curiosity and anxiety are predictive of the degree to which students will experience states of curiosity and anxiety, respectively (Leherissey, 1972a, 1972b). Therefore, to fully assess the effects of instructional treatments on student performance and motivation, it is necessary to take both trait and state curiosity and trait and state anxiety into account.

An instructional treatment which has been identified as an efficient and effective self-instructional technique is adjunct programming (Pressey, 1967; Rothkopf, 1966, 1968; Frase, 1967). This technique generally refers to the utilization of standard course materials in conjunction with an accessory program which questions the student over the materials, gives him practice in identifying and memorizing important information, and provides a means of identifying areas of student difficulty which require remediation or additional study. The insertion of questions following segments of the instructional materials has been found to improve attention to the materials, retention of the materials, as well as to stimulate more active student participation in the learning process. Although the concept of adjunct programming has traditionally been applied to existing course materials, it can also be utilized with newly developed or revised course materials.

1.2 General approach. In order to fully exploit the potential of adjunct programming within UPT, the present study sought to combine the efficiency of adjunct questions with the versatility of multi-media presentations. This combined concept was entitled Media Adjunct Programming (MAP), which also extended the concept of multi-media adjunct programming to include self-paced individualized instructional management via the adjunct media software and hardware. That is, adjunct questions over the course units were presented via a modified random access projector which provided a record of student performance and readiness for the next instructional unit. Instructional software in the form of MAP Guides provided the student with the course outline, placement of adjunct questions within the course, and routed him to the various media devices for presenting each course module.

The UPT academic course covering the basic principles of weather was chosen as a representative subject matter area for applying the MAP approach. Existing course materials and test items were modified as required for presentation on two tape/slide media devices, one with student-controlled and the other with author-controlled pacing, and a motion picture media device. The MAP course was thus individualized to the extent that students could control (1) the presentation rate of some of the more difficult course modules, (2) the pace they went through the course as a whole, (3) the times of day they reported to the multi-media learning center, (4) the time spent and response contingent feedback (correct, incorrect) they received on adjunct questions, and (5) the amount of review or length of time spent reviewing previously taken modules. Principles of educational technology, described in the following section, were applied to course development and media selection. The experimental design was basically a pretest-posttest retention test design in which students from two UPT flight groups were randomly assigned to the MAP or traditional instructor-classroom (TIC) groups on the basis of their entering knowledge of course training objectives, their trait anxiety, and their trait curiosity.

Major predictions were as follows: (1) students in the MAP group would complete the course in less time and perform equally as well on the posttest and retention test as students in the TIC group; (2) students in the MAP group would have higher levels of state curiosity during the learning task than students in the TIC group; (3) high state curious students in both the MAP and TIC groups would have lower levels of state anxiety and perform better on the achievement measures than low state curious students; and (4) high trait anxious students and high trait curious students in both the MAP and TIC groups would have higher levels of state anxiety and state curiosity, respectively, during the course than low trait anxious or low trait curious students.

2. METHOD

2.1 Subjects. Seventy-six male undergraduate pilot students scheduled for one of two conventional UPT Weather classes were randomly assigned to the MAP or TIC conditions based on their levels of prior knowledge of course training objectives as measured by the pretest (low, high), their levels of trait curiosity (low, high), and their levels of trait anxiety (low, high). These students were selected on the basis of their scores on measures administered during an initial group testing session from the population of undergraduate pilot trainees at Williams AFB normally scheduled to take the Weather course from one of two Air Training Command (ATC) instructors during an academic month. Approximately one-half of the students in both the MAP and TIC groups were selected from the conventional morning class, and one-half were selected from the conventional afternoon class.

2.2 Apparatus. Six Elco IV sound/slide media devices, four Automatic Private Tutor (APT) media devices, and four Fairchild movie projectors were used to present the MAP multi-media Weather course materials. The Elco IV and APT devices consisted of 35mm projectors with rear projection screens, carousel slide trays, and cassette-load tape recorders; the Fairchild devices consisted of super 8mm film/sound cartridges and rear projection screens. Whereas the Elco IV sound/slide devices were programmed such that the author controlled the presentation rate of each slide, the APT sound/slide devices were programmed such that the student could control the amount of time he spent on each slide by depressing a specified key on the APT response keyboard when he was ready to go on to the next slide. A limited response capability was also provided by the Elco IV, in that the student could spend more than the allotted time on a particular slide or review previous slides by using the standard tape recorder controls.

The adjunct questions were presented on a fourth media device, six modified Kodak random access projectors, which projected question and answer slides on rear projection screens and had no audio capability. Each Kodak random access projector was modified to include a photodiode and microswitch connected to the unused pins of the projector control unit which the student used to dial to particular slide numbers. The control signals from the photodiode and microswitch were fed to a printer system logic unit via special tee cables, along with slide address signals from the projector control unit. The photodiode was used to indicate a correct response by means of the presence of a properly oriented hole punched in the frame of the correct answer slides. The microswitch was used to control a timing device in the logic units, which indicated the length of time in seconds that a particular slide was viewed, and was reset on Slide 1. Tee cables were also used to interface the logic unit with a six-column strip printer which recorded each slide number dialed, whether the slide was a correct answer slide, and the accumulated time in seconds since reset. A "P" was printed in the field following the number of the correct answer slide, and a blank followed the number of a question slide or the number of an incorrect answer slide. In addition, student identification numbers were printed at the beginning of a student's performance record on each carousel tray of adjunct questions. These student identification numbers were printed as a result of the student dialing his four-digit identification number prior to placing the carousel slide tray of adjunct questions on the projector. All of the above media devices were placed in learning carrels that were located in an air conditioned learning center at Williams AFB.

The TIC classrooms contained tables, chairs, slide and 16mm movie projectors and projection screen. Each student position was equipped with an electric responder with a four choice selection possibility, a "select answer" light to command the student to respond, and lights to provide the student with a "right" or "wrong" indication as feedback.

The responders were controlled from the instructor's central control console. The central control console served as a podium for the instructor and provided him with control over the student responders, 16mm movie projector, 35mm slide projector and room illumination. The instructor inserted the correct answer into the central control console and asked the student to respond. He selected one of two modes where (1) the students response was locked in after one choice had been made, or (2) the student responded until the correct answer was obtained. In the locked position the instructor was provided with a visual display of each positions response. Counters in the console maintained a running total of errors for each student position.

During the Weather course lectures, these responder systems were used for classroom review of previously completed workbook exercises. The remainder of the classroom instruction was lecture, liberally augmented with slides and motion pictures.

2.3 Affective measures. The State Epistemic Curiosity Scale (SECS: Leherissey, 1971) was used periodically throughout the learning task to assess state epistemic curiosity. Thirty items from the Ontario Test of Intrinsic Motivation (OTIM: Day, 1969) relevant to the subject population were used to match students on trait curiosity levels. The State-Trait Anxiety Inventory (STAI: Spielberger, Gorsuch, and Luschene, 1970) was used to measure both state and trait anxiety.

The items in the trait curiosity and trait anxiety scales were randomly ordered and presented to all students in an initial group testing session with standard instructions, i.e., "indicate how you generally feel." The items in the long form (20-item) state curiosity and long form (20-item) state anxiety scales were combined, randomly ordered, and administered to all students in the MAP and TIC groups immediately following introductions to their respective instructional sessions. This first state measure was used to assess initial motivational reactions to the learning materials and was administered with instructions for students to "indicate how you think you will feel while learning the Weather course materials." The items in the short form (eight-item) state curiosity and short form (seven-item) state anxiety scales were also combined, randomly ordered, and administered to students in the MAP and TIC groups halfway through the course materials and immediately following completion of the last course unit. These state scales were used to assess intask motivational reactions and were administered with retrospective state instructions, i.e., "indicate how you felt while you were learning the Weather course materials you have just completed."

An additional affective measure, administered to all students following the ATC posttest, was a 20-item forced choice attitude toward instructional method questionnaire, compiled from previously developed student attitude forms (Federico, 1970; Finch, 1969). In addition, a four-item open ended instructor reaction form was developed to assess the attitudes of the two ATC instructors toward the MAP approach.

2.4 Instructional programs and achievement measures. The development of multi-media course materials and adjunct questions to meet ATC objectives for the Weather course followed a systems approach to the development of individualized instructional materials. Basically, this approach consisted of:

2.4.1 Task analysis of ATC objectives and pretest development. A team of behavioral psychologists, media specialists, course authors, and ATC instructors participated in the identification of enabling objectives and the types of learning associated with each training objective. The training objectives were then arranged into a hierarchy of types of learning or major subskills to be taught in each unit (Gagne, 1970). Following this course analysis, 58 pretest items were written over the objectives and submitted to the ATC instructors for content validation.

2.4.2 Lesson development and media selection. Division of the nine conventional Weather course units, previously consisting of 22 hours of classroom instruction, into flexible course modules followed the task analysis of training objectives. The course was divided into a total of 31 modules, composed of the smallest logically related segments of instruction within each unit which could be taught in an average time of 15-20 minutes, and which allowed the student maximum flexibility in scheduling his instructional time. The selection of training media for presenting each course module was then based upon a match of the types of learning and the corresponding training objectives in each module, and the characteristics of each media to be used (Allen, 1967; Lonigro and Eschenbrenner, 1971).

2.4.3 Course and adjunct question development. All ATC instructional materials for the Weather course were obtained for content analysis and subsequent selection of that material to be taught in each module. To insure content comparability between the TIC and MAP courses, one of the Williams AFB Weather classes was videotaped, and these tapes were also analyzed to select any additional material to be included within the scripts for each module presentation. Copies of all ATC slides currently used in the Weather course, as well as films, were obtained and revised as necessary. Additional films on Weather were also obtained and reviewed for inclusion in the MAP course. Those films chosen were edited and copies made for MAP presentations on the Fairchild projector devices. Scripts were written for each module and additional slides were developed as required. Each module began with a statement of the appropriate training objective, to provide the student with an orienting framework for organizing the material to be learned (Ausubel, 1968). To enhance student motivation and attention, a variety of male and female narrators were used in the production of the Elco IV and APT tape presentations of particular course modules.

Adjunct questions covering training objectives in each course module were written in multiple choice format and submitted to the ATC Weather course instructors for content validation. The correct and incorrect choices for each adjunct question were written to include both confirmation of correctness of that choice and an appropriate explanation of why the choice was correct or incorrect. The adjunct questions were programmed so that the first 15 to 20 slides were question slides and the remaining 65 or 60 slides were response slides. Thus, the student dialed each question slide and each response slide, and was routed to the next slide dependent upon the correctness or incorrectness of his response. In order to assure student mastery of the adjunct questions, the response slides instructed the student to return to missed questions until he chose the correct response.

A total of eleven sets of adjunct questions were constructed for the entire MAP course, with each of the nine units covered by at least one set. Performance criteria for first choice answers and differential remedial prescriptions for students who failed to meet criterion were established for each set of adjunct questions. Procedures for evaluating random access projector printouts of student performance on each set of adjunct questions were developed to enable the ATC Weather course instructors to prepare remedial prescriptions. These consisted of requiring students to repeat modules on which they failed to meet criterion. A MAP Instruction Booklet explaining course procedures was prepared for the students. This booklet included information on course sequence, approximate time to complete each module, flexibility for scheduling the order in which course modules were to be taken, placement and procedures for taking the adjunct questions, course completion constraints and time-off incentives for early course completion, as well as instructions for operating each media device. A *MAP Guide* for each course module, routing students to particular media and adjunct questions, was also prepared.

2.4.4 Formative evaluation and revision. All MAP course materials, adjunct questions, and pretest items were field tested on a representative sample of Williams AFB undergraduate pilots who had and had not had the conventional ATC Weather course. A total of 11 students who had the course and 8 students who had not had the course were administered the modular multi-media course materials and adjunct questions. A total of 18 students who had the course and 12 students who had not had the course were administered the 58-item pretest in separate group testing sessions. On the basis of student comments and performance on the adjunct questions, as well as comments from the two ATC Weather course instructors, modules and adjunct questions were revised as necessary. The pretest was revised to include those 40 items which best discriminated between performance of students who had and had not had the Weather course. Revised copies of all course materials were then prepared for the final evaluation. Included were five copies of all instructional materials and adjunct questions in order to insure that a sufficient number of multi-media materials for each module would be available for the MAP students to efficiently schedule their instructional time at the learning center.

2.5 Procedure. The final evaluation was divided into three periods: (1) a pretask period, during which all students scheduled for the Weather course were pretested and assigned to treatment groups; (2) a performance period, during which students learned either the MAP or TIC materials and took the three combined state curiosity and state anxiety scales at specified points during the course; and (3) a posttask period, during which all students were administered one of three alternate forms of the standard ATC Weather course posttest, the attitude toward instructional method questionnaire, and the retention test. Each of these periods is further described below.

2.5.1 Pretask period. Three days prior to the date officially scheduled for beginning the Weather course, all students scheduled for either the morning or afternoon class sessions were assigned student identification numbers and the groups were administered the combined trait anxiety/trait curiosity scale and the course pretest. Based upon their scores on each of these measures, an equal number of students scoring high and low from both the morning and afternoon classes were randomly assigned to the MAP and TIC groups.

2.5.2 Performance period. On the first class day, all students reported either to their regular classroom or the multi-media learning center, dependent upon whether they were assigned to the TIC or MAP groups, respectively. Students in the MAP group were given MAP Instruction Booklets and briefed on course procedures, scheduling constraints, given orienting instructions on the operation of the media devices, and were instructed on the use of sign-up sheets for scheduling their evening or weekend instructional time. All MAP students were told that they must complete at least five course units in the time allotted for the TIC group to complete the first five units, complete the entire course by the last day of class for the TIC group, take the posttest the day immediately following completion of the last course module, and schedule their reviews of course materials or adjunct questions as desired. In addition, MAP students were told to do their best on each set of adjunct questions since the ATC Weather course instructors would be reviewing their individual performance records and would ask them to repeat modules on which they had difficulty answering the questions. They were also informed that the two ATC instructors would be available for consultation or tutoring on course materials they found particularly difficult.

As soon as each student in the MAP group completed the introductory module and the students in the TIC group received their introductory lecture, they were administered the first combined state curiosity and state anxiety scale which asked them to indicate how they thought they would feel while learning the Weather course materials. Immediately after each student in the MAP group finished the last module in Unit 5 and the last module in Unit 9, he was administered the second and third combined state curiosity and state anxiety scales with instructions to indicate how he felt while learning the materials he had just completed. Students in the TIC groups were administered these scales upon completion of the instruction for the first five units and on the last day of classroom instruction. Two to three experimenters were present at the learning center to assist MAP students as necessary. Adjunct question performance records for each course module were analyzed each day by the two ATC Weather instructors, and remedial prescriptions were prepared for those students who were required to complete particular modules. These prescriptions were given to the student when he reported for his next instructional session.

2.5.3 Posttask period. On the day immediately following his completion of the last course module, each student in the MAP group was administered the attitude toward instructional method questionnaire and randomly given one of the three alternate forms of the standard ATC posttest. At the end of this posttask testing session, each MAP student was cautioned not to discuss the posttest with either his MAP or TIC classmates. MAP students who completed the course prior to the final TIC class day were given time-off incentives, or free time during their regularly scheduled classroom hours. Students in the TIC groups were administered the attitude toward instructional method quesionnaires and one of the three alternate forms of the ATC posttest in their respective classrooms on the day immediately following the last class day. Exactly six days after each student in the MAP group had completed the Weather course and posttest, he was told to report to one of the ATC instructors for a retention test over the course materials. This retention test consisted of one of the three alternate forms of the ATC posttest, again selected randomly. Students in the TIC groups were told to report back to their classrooms six days after the posttest and were also administered a retention test consisting of one of the three alternate forms of the ATC posttest.

3. RESULTS

The data analyses are categorized into the following major sections: (a) Reliability and Validity of Test Instruments; (b) Performance Results; (c) Anxiety, Curiosity and Attitude Results; and (d) Learning Time Results.

The first section reports reliability data on the SECS scales, OTIM scales, attitude toward instruction scales, STAI trait/anxiety scales, and the criterion-referenced pretest plus concurrent and construct validity of the SECS scales.

In the second section, the analyses are divided into: (a) anxiety and performance analyses, and (b) curiosity and performance analyses. These data analyses investigate the hypothesized relationships between curiosity, anxiety, and performance as a function of treatment conditions. The dependent variables in these analyses are pretest, posttest and retention test scores.

In the third section, the analyses are organized into: (a) anxiety and curiosity analyses and (b) attitude analyses. These analyses investigate the hypothesized relationships between trait and state anxiety, trait and state curiosity, state curiosity and state anxiety, as well as the effects of trait anxiety, trait curiosity, and instructional treatments on student attitude.

In the fourth section, the analyses reported examine the effect of treatment variables on the total time spent in the MAP and TIC conditions. These analyses also report the relationship between class groups and learning time data for students in the MAP condition.

3.1 Reliability and validity of test instruments.

3.1.1 Reliability results

3.1.1.1 State epistemic curiosity scale reliability. The means, standard deviations, and alpha reliability (internal consistency) coefficients for the 20-item pre-task SECS and the two short form (8-item) mid-task and end-of-task SECS scale are reported in Table 1.

TABLE 1

Means, Standard Deviations, and Alpha Reliabilities of the Three State Epistemic Curiosity Scales Administered During the Experiment (N = 62)

Scale	Scale Range	Mean	SD	Alpha
Pre-task SECS	20-80	60.94	5.85	.74
Mid-task SECS	8-32	24.45	3.72	.77
End-of-task SECS	8-32	25.34	3.64	.79

As Table 1 indicates, the alpha reliabilities of the SECS scales ranged between .74 and .79, indicating moderately high internal consistencies on both the long and short forms of the SECS scale.

3.1.1.2 Ontario test of intrinsic motivation and attitude toward instruction questionnaire reliability. In order to insure that the shortened form (20-item) of the OTIM, which was used to match students on levels of trait specific curiosity, was a reliable instrument, an alpha reliability coefficient was calculated for this scale. In addition, an alpha reliability coefficient was calculated for the 20-item attitude toward instruction questionnaire, which was administered to students in the MAP and TIC groups following completion of their respective Weather course classes. The means, standard deviations, and alpha reliabilities for these scales are reported in Table 2.

TABLE 2

Means, Standard Deviations and Alpha Reliabilities of the OTIM and Attitude Toward Instruction Scales (N = 62)

Scale	Scale Range	Mean	SD	Alpha
OTIM	20-80	56.03	8.69	.85
	20-80	64.44	8.04	.87

For the data reported in Table 2, it may be noted that alpha reliabilities of .85 and .87 were found for the OTIM and attitude toward instruction scale, respectively, indicating high internal consistencies for these measures.

3.1.1.3 State-trait anxiety inventory reliability. The means, standard deviations, and alpha reliability coefficients calculated for the STAI 20-item trait anxiety scale, 20-item pre-task state anxiety scale, and two short-form (7-item) mid-task and end-of-task state anxiety scales are reported in Table 3.

As shown in Table 3, the reliability of the STAI trait anxiety scale was found to be .88. The alpha reliabilities of the STAI state anxiety scales ranged from .78 to .89 for the long and short versions of this scale. Thus, the STAI scales were found to have moderately high internal consistencies during the experiment.

TABLE 3

Means, Standard Deviations, and Alpha Reliabilities of the STAI Scales Administered During the Experiment (N = 62)

Scale	Scale Range	Mean	SD	Alpha
Trait Anxiety	20-80	35.53	7.26	.88
Pre-task State Anxiety	20-80	32.53	7.22	.88
Mid-task State Anxiety	7-28	10.23	3.07	.78
End-of-task State Anxiety	7-28	10.13	3.55	.89

3.1.1.4 <u>Criterion-referenced pretest reliability</u>. An alpha reliability coefficient was calculated to insure that the 40-item pretest, developed for the purpose of matching students in the MAP and TIC groups on their levels of prior knowledge of Weather course objectives, was a reliable instrument. The mean, standard deviation, and alpha reliability coefficient for the pretest are shown in Table 4. It should be noted that there were a total of 150 possible right answers within the 40-item pretest. Each of these possible answers was scored 2 or 1, depending on whether it was right or wrong, respectively.

TABLE 4

Mean, Standard Deviation, and Alpha Reliability Coefficient for the Criterion-Referenced Pretest (N = 62)

Scale	Scale Range	Mean	SD	Alpha
Pretest	150-300	228.90	16.57	.92

Table 4 reports that an alpha reliability of .92 was found for the criterion-referenced pretest, indicating high internal consistency for this measure.

In summary, the reliability results for the above scales administered during the experimental session reflect acceptable internal consistencies.

3.1.2 State epistemic curiosity scale validity results.

3.1.2.1 Concurrent validity. As evidence of the concurrent validity of the 20-item SECS and the two short form (8-item) SECS scales, these scales were correlated with the OTIM scale. Since the OTIM was considered to be a trait measure of specific curiosity and the SECS was assumed to be a state measure of specific epistemic curiosity, moderately high positive correlations between these measures were expected. The correlations between the pre-task SECS, mid-task SECS, end-of-task SECS and OTIM are reported in Table 5.

TABLE 5

Correlations of SECS Scales with the OTIM Scale (N = 62)

SECS Scales	OTIM Correlations
Pre-task SECS	.50**
Mid-task SECS	.31*
End-of-task SECS	.46**

*p < .05
**p < .001

The correlations shown in Table 5 all indicate significant positive relationships between the three SECS scales and the OTIM. These moderately high positive correlations are within the range of correlations found between trait and state anxiety, as measured by the STAI (Spielberger, et al, 1970).

3.1.2.2 Construct validity. Evidence which can be considered to bear on the construct validity of the SECS is provided by the correlations of the various SECS scales with the STAI trait and state scales. Because of the inverse relationship which has been found between state curiosity and state anxiety (McCombs, 1972), moderately high negative correlations between the SECS scales and STAI state anxiety scales were expected. In contrast, since trait anxiety implies a relatively stable personality predisposition which does not reflect situational factors, relatively low negative correlations between the STAI trait anxiety scale and SECS scales were expected. The correlations between the SECS and STAI scales are shown in Table 6.

TABLE 6

Correlations of SECS Scales with STAI Scales for Total Group (N = 62)

Scale	STAI Correlations			
	A-Trait	Pre A-State	Mid A-State	End-A-State
Pre SECS	-.07	.13	.14	.16
Mid SECS	.23	.07	-.16	.02
End SECS	.12	.05	.01	.03

As can be seen in Table 6, insignificant correlations between the SECS scales and STAI state anxiety scales ranged between -.16 and .16, indicating little consistency in the relationship between state curiosity and state anxiety for the students in this study. In addition, the correlations between the SECS scales and STAI trait anxiety scale indicated that only the pre-task SECS had a low negative relationship (r = -.07, n.s.) with trait anxiety.

In order to determine whether the relationships between curiosity and anxiety were differential for students in the two flight groups of MAP and TIC students (John Black, JB, and No Loss, NL), separate correlations between the SECS and STAI scales were calculated for these groups. Table 7 gives the correlations between the SECS and STAI for students in the MAP-JB, MAP-NL, TIC-JB, and TIC-NL groups.

Table 7 shows that the pattern of correlations between curiosity and anxiety varied dependent on treatment condition (MAP versus TIC) and UPT class groups (JB versus NL). For students in the NL classes, correlations between the SECS and STAI scales were in the predicted direction, with significant negative correlations found between the pre-task and mid-task SECS and STAI state anxiety scales for students in the MAP-NL group. For the remaining experimental groups, inconsistent nonsignificant relationships were found between state anxiety and state curiosity.

Additional evidence bearing on the construct validity of the SECS is provided by the correlations between the various SECS scales, the posttest, and the retention test for the experimental groups. State epistemic curiosity was assumed to facilitate performance, and thus moderately high positive correlations were expected between the SECS scales and achievement measures. The correlations between the three SECS scales, posttest, and retention test for the total, MAP, and TIC groups are reported in Table 8.

TABLE 7

Correlations of SECS and STAI Scales
for the Four Experimental Groups

	SECS Correlations											
	Pre SECS				Mid SECS				End SECS			
	MAP		TIC		MAP		TIC		MAP		TIC	
	JB n=15	NL n=16	JB n=14	NL n=17	JB n=15	NL n=16	JB n=14	NL n=17	JB n=15	NL n=16	JB n=14	NL n=17
A-Trait	-.04	-.44	.41	-.17	.35	.07	.63*	-.04	.19	.10	.25	-.18
Pre A-State	.24	-.86**	.28	-.24	.04	-.10	.38	-.16	.01	-.05	.46	-.45
Mid A-State	.48	-.42	.42	.35	-.01	-.60*	.20	.14	-.08	-.29	.26	.08
End A-State	.16	-.38	.29	.27	.02	-.46	.14	.24	.03	-.39	.40	-.20

* p < .05
** p < .001

TABLE 8

Correlations of SECS Scales and
Achievement Measures

	Achievement Measures					
	Posttest			Retention		
	MAP n = 31	TIC n = 31	TOTAL N = 62	MAP n = 31	TIC n = 31	TOTAL n = 62
Pre-task SECS	-.14	.15	.01	-.34	.26	-.01
Mid-task SECS	.23	.32	.26*	.04	.36*	.16
End-of-task SECS	.10	.22	.15	-.04	.40*	.16

*p < .05

As indicated in Table 8, the SECS scales correlated differentially with the achievement measures for the MAP and TIC groups. The expected positive correlations between state epistemic curiosity and achievement were found for those SECS scales given closest in time to the retention test for students in the TIC groups. In addition, a significant correlation between the mid-task SECS scale and achievement posttest was found for the total group ($r = .26$, $p < .05$). The remaining correlations ranged from -.14 to .32 (n.s.) on the posttest and from -.34 to .16 (n.s.) on the retention test.

In summary, the SECS validity analyses indicated that the SECS scales had supportive concurrent validity, as evidenced by the predicted moderately high positive correlations between the SECS and OTIM. The construct validity findings were mixed, with supportive correlational data on the inverse relationship between state curiosity and state anxiety for the MAP groups and some supportive correlational data on the positive relationship between state curiosity and achievement for the TIC groups.

3.2 Performance results.

3.2.1 Anxiety and performance analyses.

3.2.1.1 Effects of treatment conditions, classes, and trait anxiety levels on pretest scores. In order to insure that students from the JB and NL classes, assigned to the MAP or TIC conditions according to their levels of trait anxiety (low, high), were well-matched on pretest scores, a 2 x 2 x 2 analysis of variance was calculated. The students were divided into low and high trait anxious groups on the basis of their scores on the STAI trait anxiety scale. The total distribution of these scores was ranked and split at the median. The MAP-JB, MAP-NL, TIC-JB, and TIC-NL groups were then separated out of this distribution. The range of low trait anxious scores was 21-37; high trait anxious scores ranged from 38-55. The dependent variable in this analysis was mean scores on the pretest, which assessed students' prior knowledge of Weather course objectives. These pretest scores were converted to percentages out of 100 to allow for a comparison of pretest, posttest, and retention score gains as a result of the instructional treatments.

The means and standard deviations of low and high trait anxious students in treatment conditions and class groups on the pretest are reported in Table 9.

Results of the analysis of variance on these data revealed main effects or interactions significant beyond $p < .05$ levels. There was a tendency, however, for students in the JB ($\bar{X} = 55.09$) class group to have higher pretest scores than students in the NL ($\bar{X} = 50.13$) class group ($F = 3.21$, $df = 1/54$, $p < .08$). For this reason, the subsequent analyses will block on class groups. In addition, there was a tendency for class groups to interact with trait anxiety levels ($F = 3.10$, $df = 1/54$, $p < .08$). This interaction, shown in Figure 1, indicated that whereas low trait anxious students in the JB group performed less well than high trait anxious students in the JB group, the reverse was true for low and high trait anxious students in the NL group.

3.2.1.2 Effects of treatment conditions, classes, and trait anxiety levels on achievement scores. To determine the effects of treatment conditions (MAP, TIC), UPT classes (JB, NL), and trait anxiety levels (low, high) on achievement during the experimental session, a 2 x 2 x 2 x 3 analysis of variance with repeated measures on the last factor was calculated. The repeated measures factor consisted of the three testing periods for all students (pre, post, delayed). The dependent variables in this analysis were scores on the pretest, posttest, and retention test. All the scores in this analysis were percentages out of 100 on the three 40-item tests.

The means and standard deviations of low and high trait anxious students in treatment conditions and class groups on the posttest and retention test are reported in Table 10. (The means and standard deviations for these groups on the pretest were reported in Table 9.)

Results of the analysis of variance on these data indicated that achievement scores changed significantly across the three measurement periods ($F = 1024.75$, $df = 2/108$, $p < .001$). All groups had lower scores on the pretest ($\bar{X} = 52.61$) than on either the posttest ($\bar{X} = 96.77$) or retention test ($\bar{X} = 94.53$). The interaction between classes, trait anxiety, and measurement periods shown in Figure 2, was also found to be significant ($F = 5.01$, $df = 2/108$, $p < .025$). This interaction indicated that students performed differently on the pretest, posttest, and retention test dependent on their class groups and level of trait anxiety. No other main effects or interactions in this analysis were significant.

In order to explicate the relationships between treatment conditions, class groups, and levels of trait anxiety on posttest and retention test scores, an additional 2 x 2 x 2 x 2 analysis of variance with repeated measures on the last factor was calculated on the data in Table 10. Results of this analysis indicated that all groups had significantly higher scores on the posttest ($\bar{X} = 96.77$) than on the retention ($\bar{X} = 94.53$) test ($F = 18.04$, $df = 1/54$, $p < .001$). High trait anxious ($\bar{X} = 96.67$) students also tended to have higher

TABLE 9

Mean Pretest Scores for Low and High Trait Anxious Students in Treatment Conditions and Class Groups

	Trait Anxiety Groups	Pretest
MAP-JB	Low (n = 7)	
	Mean	49.57
	SD	6.63
	High (n = 8)	
	Mean	61.25
	SD	9.29
MAP-NL	Low (n = 9)	
	Mean	52.67
	SD	9.59
	High (n = 7)	
	Mean	48.86
	SD	7.03
TIC-JB	Low (n = 8)	
	Mean	54.38
	SD	14.07
	High (n = 6)	
	Mean	55.17
	SD	10.87
TIC-NL	Low (n = 9)	
	Mean	51.11
	SD	13.78
	High (n = 8)	
	Mean	47.88
	SD	11.48

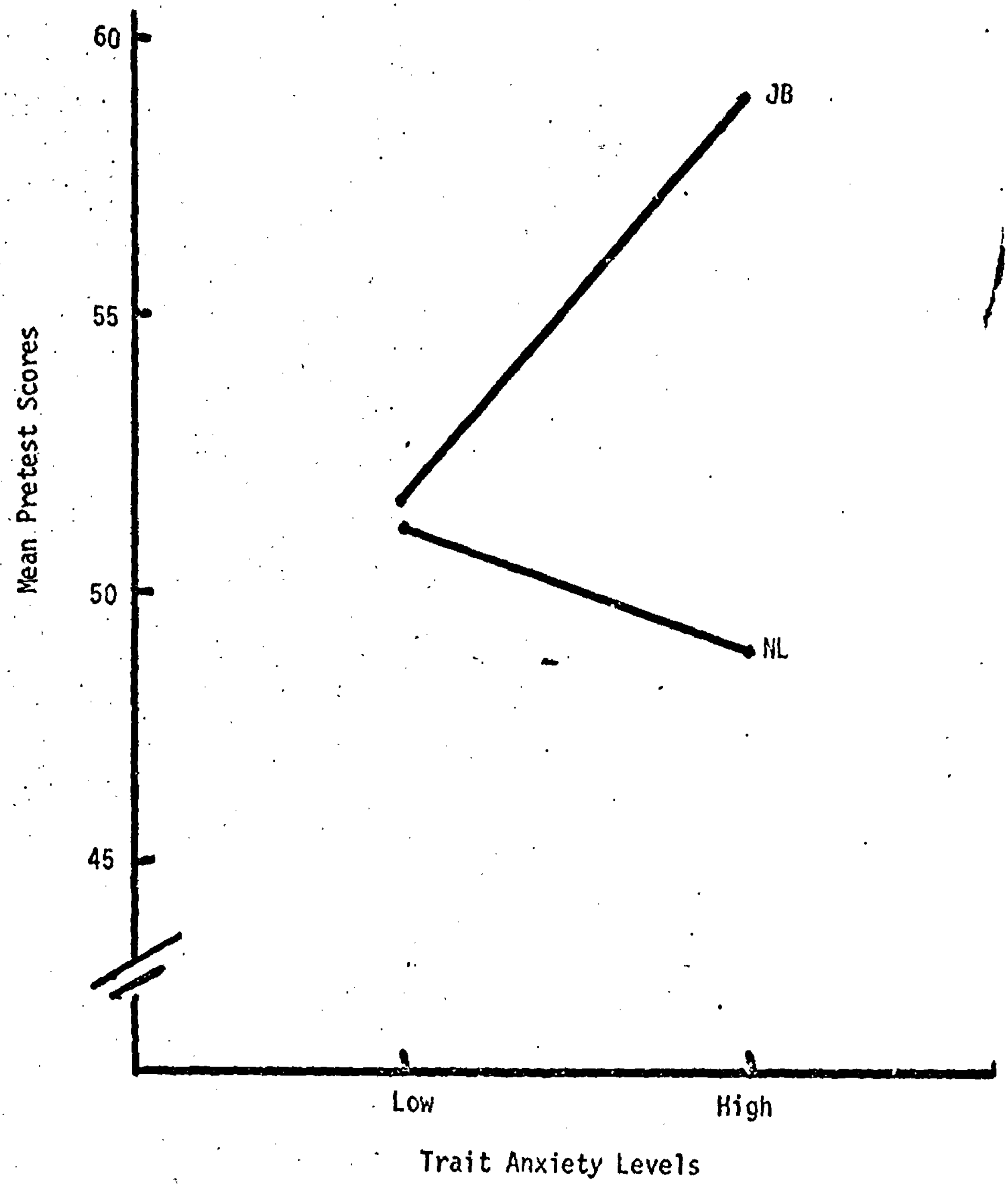
60
55
50
45
Mean Pretest Scores
JB
NL
Low
High
Trait Anxiety Levels

FIGURE 1

TABLE 10

Mean Posttest and Retention Test Scores for Low and High Trait Anxious Students in Treatment Conditions and Class Groups

Trait Anxiety Groups		Achievement Measures: Posttest	Achievement Measures: Retention
MAP-JB	Low (n = 7)		
	Mean	93.29	93.86
	SD	4.72	6.01
	High (n = 8)		
	Mean	97.88	95.25
	SD	2.47	2.82
MAP-NL	Low (n = 9)		
	Mean	95.00	90.22
	SD	4.47	8.54
	High (n = 7)		
	Mean	99.14	95.71
	SD	1.07	2.29
TIC-JB	Low (n = 8)		
	Mean	97.50	98.00
	SD	2.39	2.67
	High (n = 6)		
	Mean	98.00	98.00
	SD	2.45	2.45
TIC-NL	Low (n = 9)		
	Mean	98.33	92.33
	SD	2.50	7.45
	High (n = 8)		
	Mean	95.25	95.00
	SD	3.28	2.67

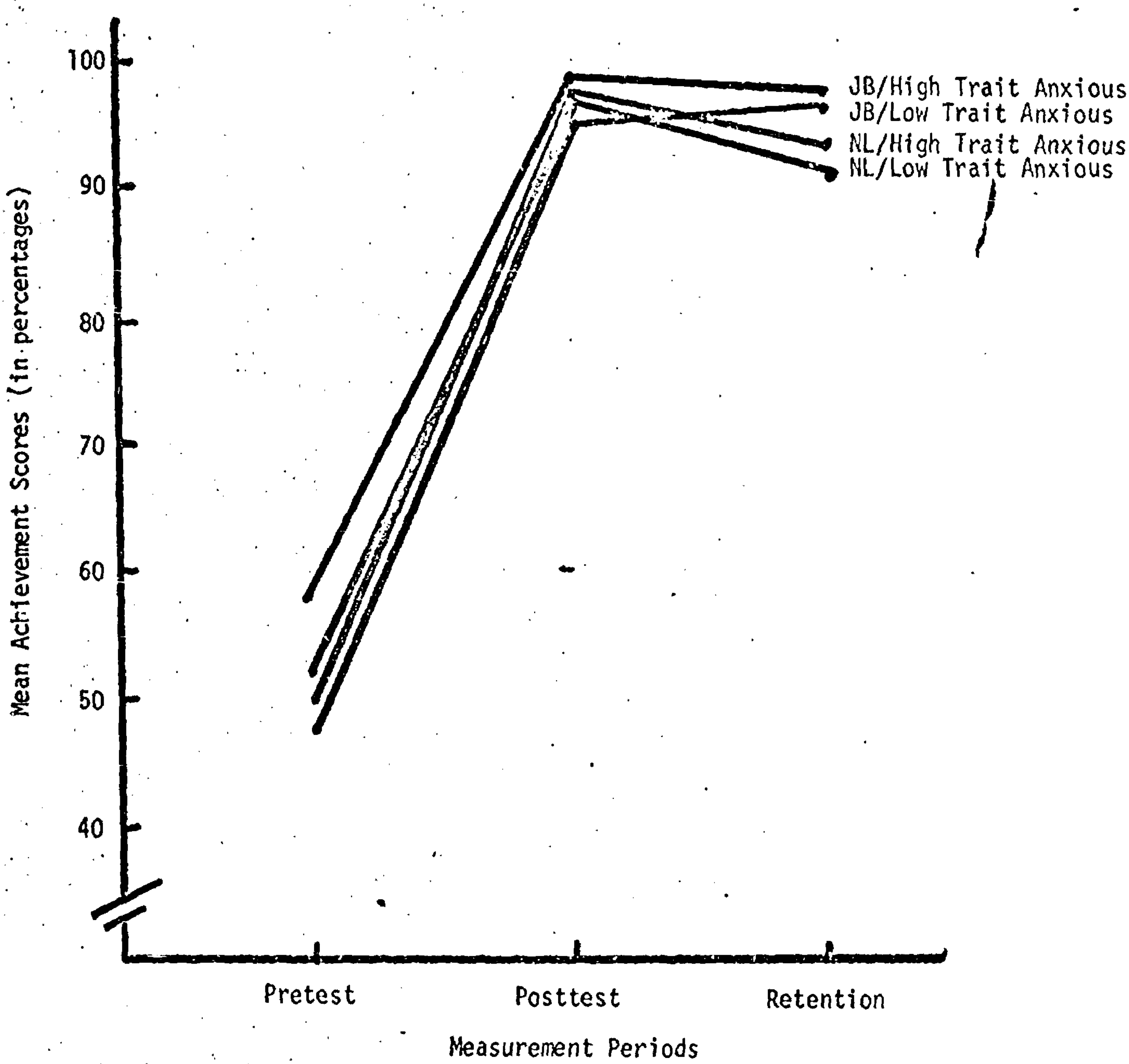
100
90
80
70
60
50
40
Mean Achievement Scores (in percentages)
JB/High Trait Anxious
JB/Low Trait Anxious
NL/High Trait Anxious
NL/Low Trait Anxious
Pretest
Posttest
Retention
Measurement Periods

FIGURE 2

scores on these two achievement measures than low trait anxious ($\bar{X}$ = 94.76) students (F = 3.98, df = 1/54, p < .06). In addition, three interactions were significant: (a) treatment conditions by trait anxiety levels (F = 4.45, df = 1/54, p < .05), shown in Figure 3; (b) class groups by measurement periods (F = 10.15, df = 1/54, p < .001), shown in Figure 4; and (c) class groups by trait anxiety levels by measurement periods (F = 7.44, df = 1/54, p < .01), shown in Figure 5.

The treatment conditions by trait anxiety levels interaction shown in Figure 3 indicated that in the MAP condition, low trait anxious students performed less well than high trait anxious students, while there was relatively little difference in the performance of low and high trait anxious students in the TIC groups. In Figure 4, the class groups by measurement periods interaction indicated that whereas there was relatively little difference in performance from the posttest to retention test for students in the JB class groups, students in the NL group performed better on the posttest than on the retention test. The triple interaction between class groups, trait anxiety levels, and measurement periods shown in Figure 5 indicated that with the exception of the JB/low trait anxious group, scores of students in the remaining trait anxiety and class groups tended to drop from the posttest to retention test. For low trait anxious students in the NL group, in particular, scores decreased from the posttest to the retention test.

3.2.1.3 <u>Effects of treatment conditions, classes, and pretask state anxiety on achievement scores</u>. Of interest in the present investigation was the relationship between pretask state anxiety, treatment conditions, class groups, and achievement scores on the Weather course. To examine this relationship, a 2 x 2 x 2 x 2 analysis of variance with repeated measures on the last factor was calculated. The students were divided into low and high pretask state anxiety groups on the basis of their scores on the 20-item STAI state anxiety measure administered following the respective introductions to the Weather course for the MAP and TIC groups. The total distribution of these scores was ranked and split at the median, and the MAP-JB, MAP-NL, TIC-JB and TIC-NL groups were separated out of this distribution. The range of low state anxious scores was 20-30; high state anxious scores ranged from 31-51. The dependent variables in this analysis were scores on the posttest and retention test.

The means and standard deviations of low and high pretask state anxiety groups in treatment conditions and class groups on the posttest and retention test are given in Table 11.

Results of the analysis of variance on these data revealed the main effect of measurement periods (F = 15.17, df = 1/54, p < .001) and the interaction between class groups and measurement periods (F = 8.44, df = 1/54, p < .01), which were also reported in the preceding analysis. In addition, there was a significant interaction between treatment conditions, class groups, and levels of pretask state anxiety. This interaction, shown in Figure 6, indicated that low pretask state anxious students in the TIC-NL and MAP-JB groups performed slightly better than high pretask state anxious students in these groups; there was relatively little difference in the performance of low and high pretask

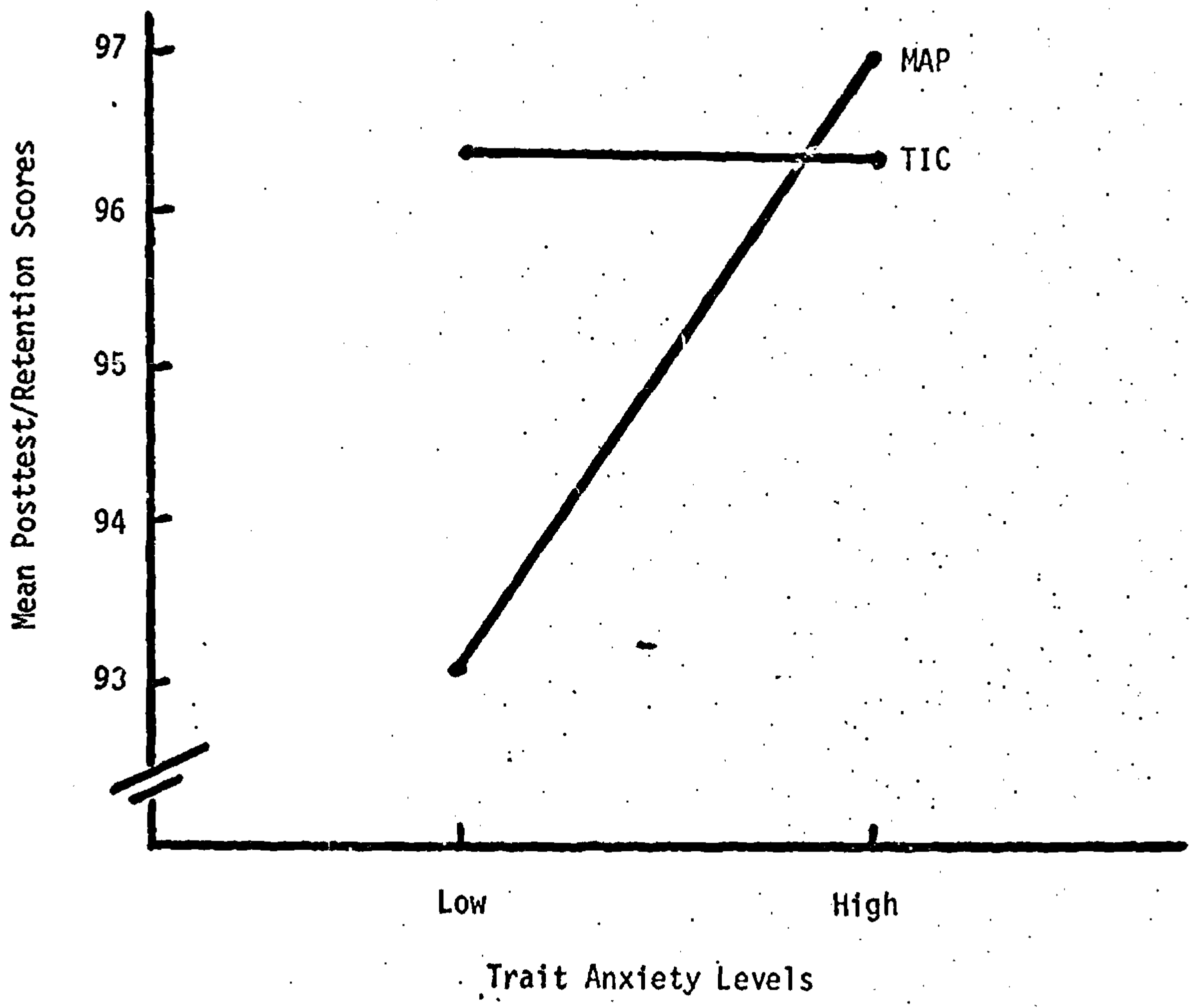
97
96
95
94
93
Mean Posttest/Retention Scores
MAP
TIC
Low
High
Trait Anxiety Levels

FIGURE 3

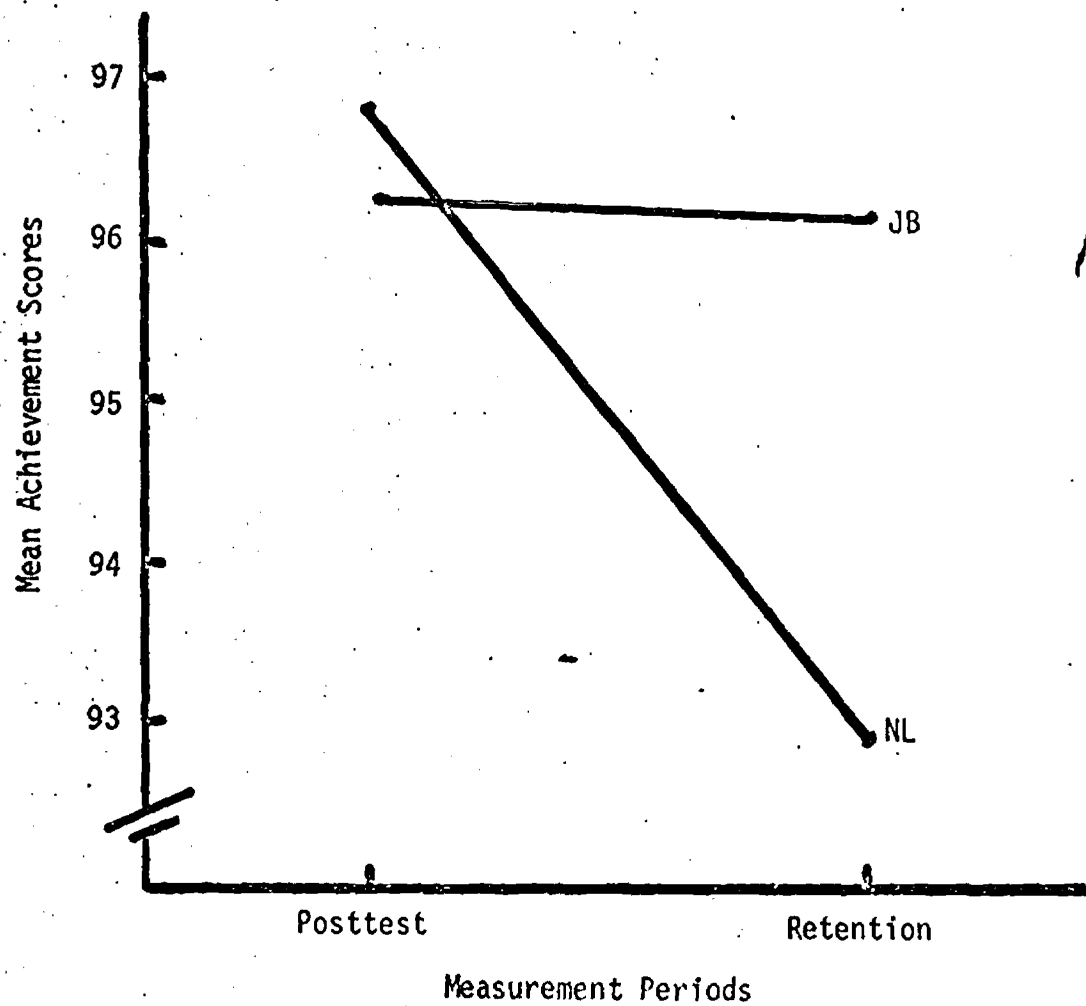
97
96
95
94
93
Mean Achievement Scores
JB
NL
Posttest
Retention
Measurement Periods

FIGURE 4

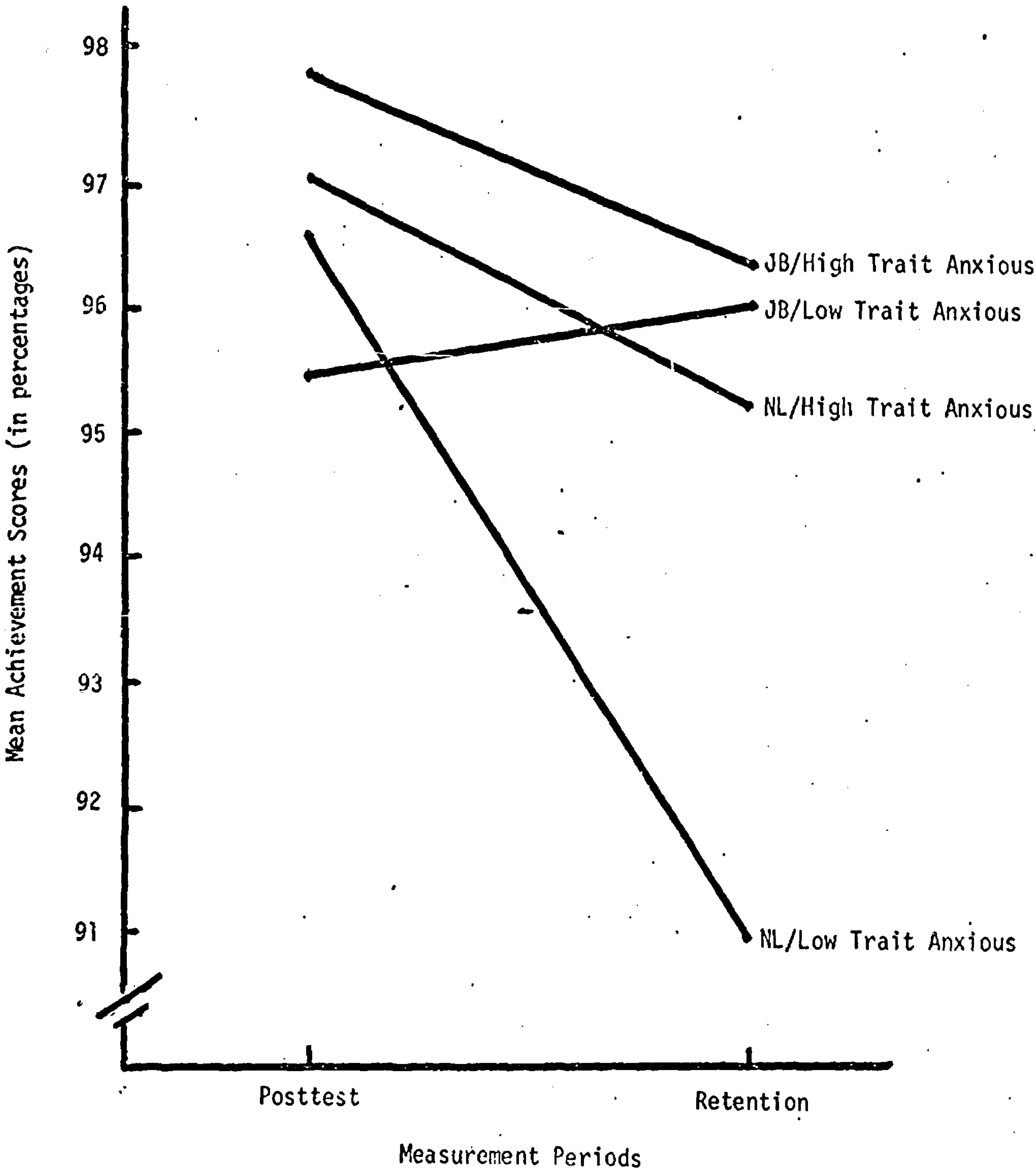
98
97
96
95
94
93
92
91
Mean Achievement Scores (in percentages)
JB/High Trait Anxious
JB/Low Trait Anxious
NL/High Trait Anxious
NL/Low Trait Anxious
Posttest
Retention
Measurement Periods

FIGURE 5

TABLE 11

Mean Posttest and Retention Test Scores
for Low and High Pretest State Anxious
Students in Treatment Conditions and Class Groups

	Pretask State Anxiety Groups	Achievement Measures Posttest	Achievement Measures Retention
MAP-JB	Low (n = 7)		
	Mean	96.14	95.71
	SD	3.98	4.68
	High (n = 8)		
	Mean	95.38	93.63
	SD	4.75	4.34
MAP-NL	Low (n = 9)		
	Mean	95.22	89.67
	SD	4.68	7.97
	High (n = 7)		
	Mean	98.86	96.43
	SD	1.07	2.76
TIC-JB	Low (n = 7)		
	Mean	97.43	98.00
	SD	2.57	2.89
	High (n = 7)		
	Mean	98.00	98.00
	SD	2.24	2.24
TIC-NL	Low (n = 8)		
	Mean	98.25	93.63
	SD	2.76	3.20
	High (n = 9)		
	Mean	95.67	93.56
	SD	3.24	7.52

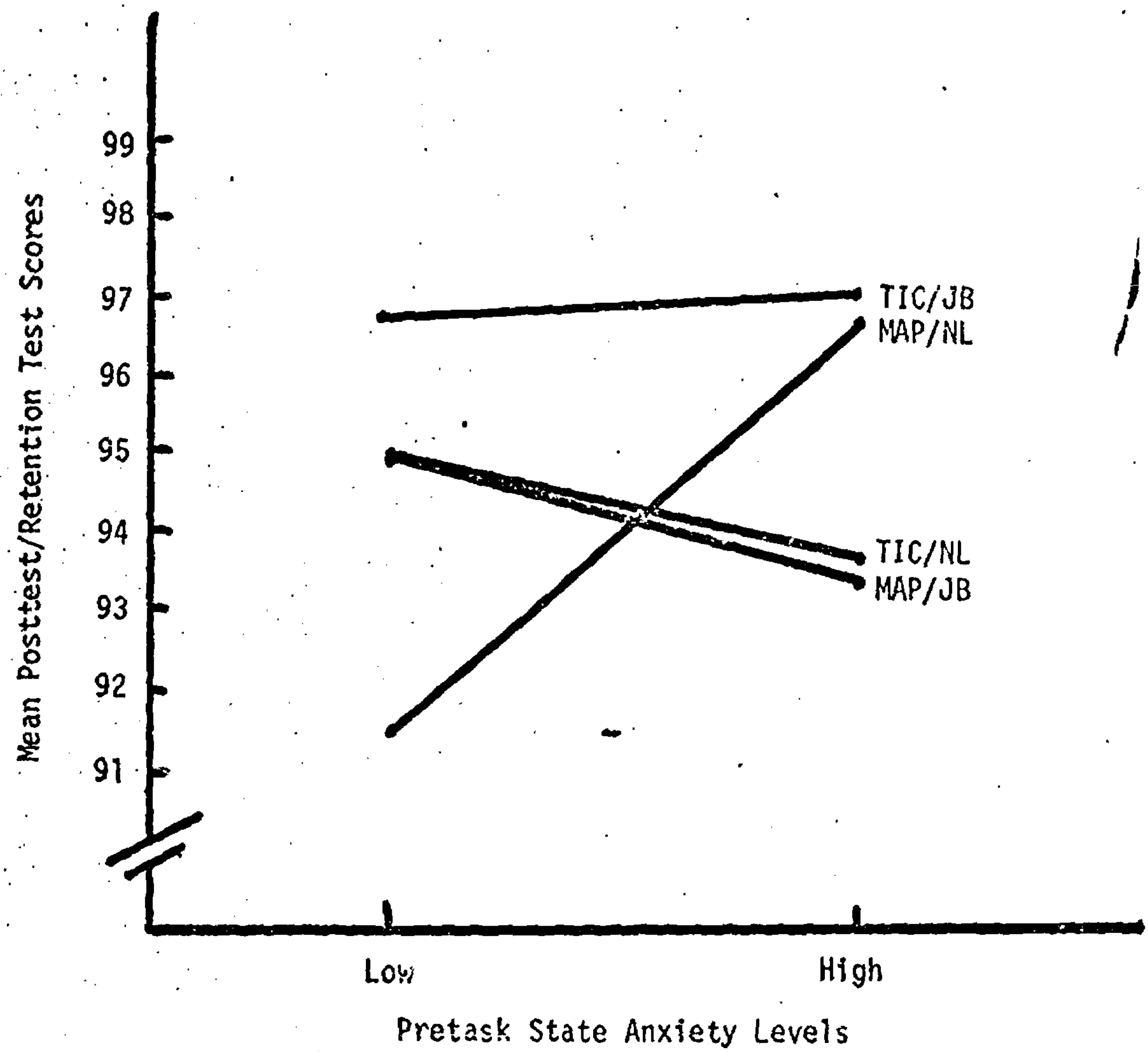
Mean Posttest/Retention Test Scores
99
98
97
96
95
94
93
92
91
TIC/JB
MAP/NL
TIC/NL
MAP/JB
Low
High
Pretask State Anxiety Levels

FIGURE 6

state anxious students in the TIC-JB group, whereas high pretask state anxious students in the MAP-NL group performed considerably better on the achievement measures than low pretask state anxious students in this group. No other main effects or interactions in this analysis were significant.

3.2.2 Curiosity and performance analyses.

3.2.2.1 Effects of treatment conditions, classes, and trait curiosity levels on pretest scores. The relationship between trait curiosity levels (low, high), treatment conditions (MAP, TIC), and class groups (JB, NL) on pretest scores was examined by a 2 x 2 x 2 analysis of variance. The students were divided into low and high trait curious groups on the basis of their scores on the shortened 20-item OTIM scale. The total distribution of these scores was ranked and split at the median. The MAP-JB, MAP-NL, TIC-JB, and TIC-NL groups were then separated out of this distribution, yielding an unequal number of students in each group. The range of low trait curious scores was 33-55; high trait curious scores ranged from 56-75.

The means and standard deviations of low and high trait curious students in treatment conditions and class groups on the pretest are given in Table 12.

Results of the analysis of variance on these data revealed no main effects or interactions significant beyond $p < .05$ level. However, there was a tendency for students in the JB ($\bar{X} = 55.09$) class groups to perform better on the pretest than students in the NL ($\bar{X} = 50.13$) class group ($F = 3.31$, df = 1/54, $p < .07$). In addition, the interaction between class groups and trait curiosity levels approached significance ($F = 3.23$, df = 1/54, $p < .07$). This interaction, shown in Figure 7, indicated that low trait curious students in the JB and NL groups performed equally as well on the pretest, while high trait curious students in the JB group performed better than high trait curious students in the NL group.

3.2.2.2 Effects of treatment conditions, classes, and trait curiosity levels on achievement scores. To determine the effects of trait curiosity levels (low, high), treatment conditions (MAP, TIC), and class groups (JB, NL) on posttest and retention test achievement, a 2 x 2 x 2 x 2 analysis of variance with repeated measures on the last factor was calculated.

The means and standard deviations of low and high trait curious students in treatment conditions and class groups on the posttest and retention test are reported in Table 13.

Results of the analysis of variance on these data indicated, as in the anxiety analyses, that scores significantly decreased from posttest ($\bar{X} = 96.77$) to retention ($\bar{X} = 94.53$) test ($F = 16.04$, df = 1/54, $p < .001$). The interaction between class groups and measurement periods was again significant ($F = 8.93$, df = 1/54, $p < .01$), and is shown in Figure 4. In addition, the treatment conditions by trait curiosity levels by measurement periods interaction was significant ($F = 4.77$, df = 1/54 $p < .05$), and is shown in Figure 8. This interaction indicated that whereas low trait curious students in the MAP and TIC groups performed at relatively the same levels on the posttest and retention test, high trait curious students in the TIC groups performed better than high curious students in the MAP groups, particularly on the retention test. No other main effects of interactions in this analysis were significant.

TABLE 12

Mean Pretest Scores for Low and High Trait Curious Students in Treatment Conditions and Class Groups

Trait Curiosity Groups		Pretest
MAP-JB	Low (n = 8)	
	Mean	51.88
	SD	6.33
	High (n = 7)	
	Mean	60.29
	SD	11.77
MAP-NL	Low (n = 8)	
	Mean	51.63
	SD	7.41
	High (n = 8)	
	Mean	50.38
	SD	10.00
TIC-JB	Low (n = 7)	
	Mean	51.00
	SD	15.68
	High (n = 7)	
	Mean	58.43
	SD	7.18
TIC-NL	Low (n = 8)	
	Mean	43.88
	SD	18.33
	High (n = 9)	
	Mean	48.22
	SD	16.70

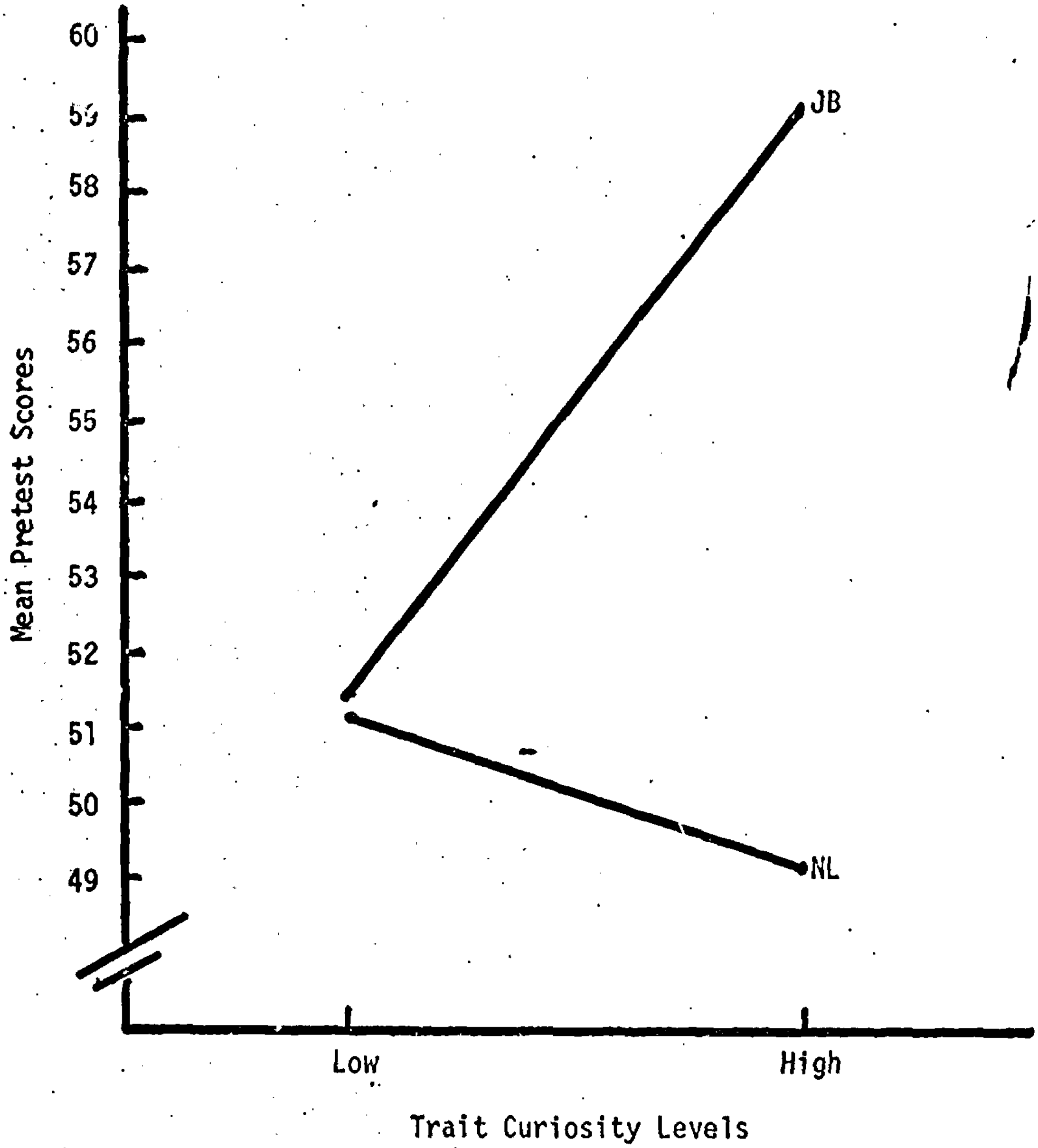
60
59
58
57
56
55
54
53
52
51
50
49
Mean Pretest Scores
JB
NL
Low
High
Trait Curiosity Levels

FIGURE 7

TABLE 13

Mean Posttest and Retention Test Scores
for Low and High Trait Curious Students
in Treatment Conditions and Class Groups

	Trait Curiosity Groups	Achievement Measures: Posttest	Achievement Measures: Retention
MAP-JB	Low (n = 8)		
	Mean	94.75	95.00
	SD	5.12	5.48
	High (n = 7)		
	Mean	96.86	94.14
	SD	3.02	3.34
MAP-NL	Low (n = 8)		
	Mean	99.25	95.38
	SD	1.04	2.32
	High (n = 8)		
	Mean	94.38	89.88
	SD	4.34	9.06
TIC-JB	Low (n = 7)		
	Mean	97.71	97.43
	SD	2.75	2.57
	High (n = 7)		
	Mean	97.71	98.57
	SD	2.06	2.44
TIC-NL	Low (n = 8)		
	Mean	97.88	91.75
	SD	2.47	7.63
	High (n = 9)		
	Mean	96.00	94.89
	SD	3.67	3.30

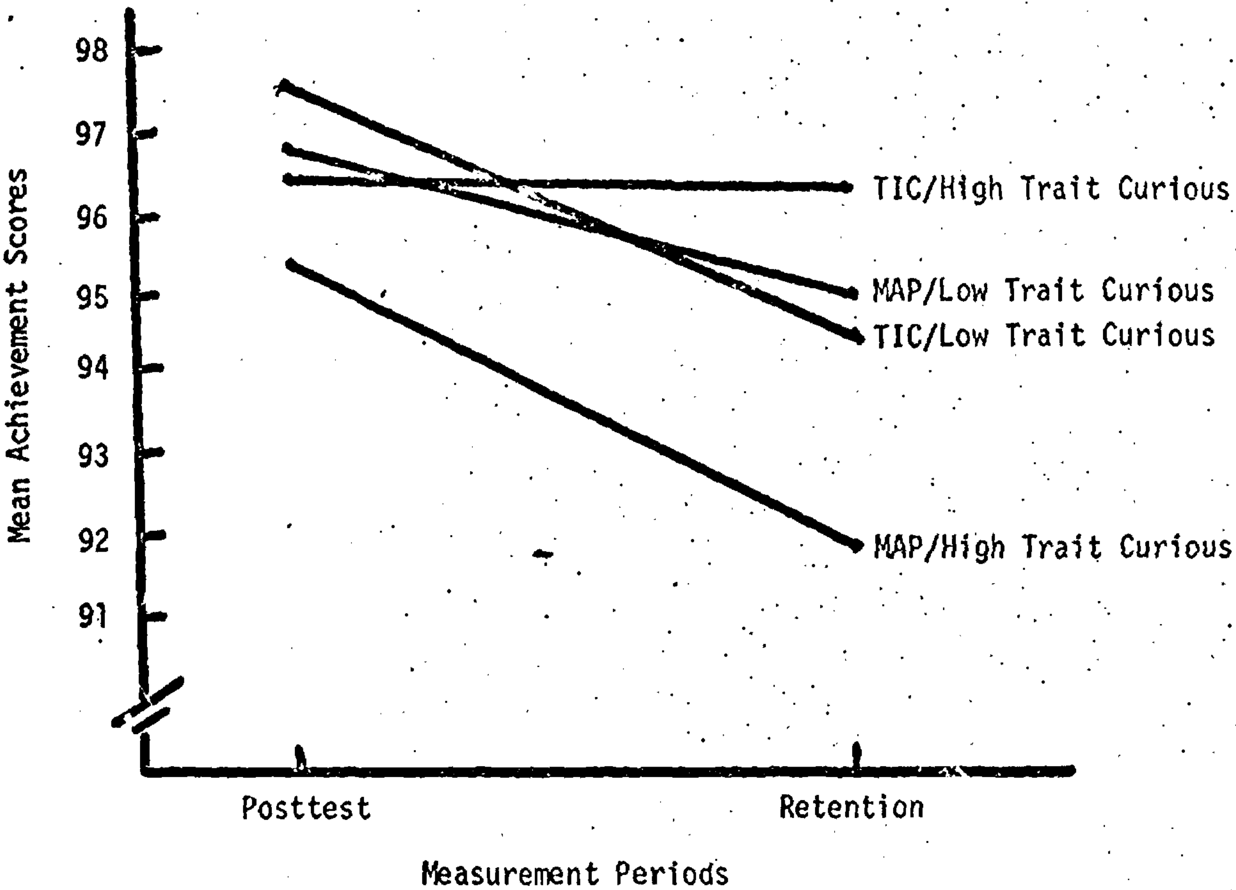
98
97
96
95
94
93
92
91
Mean Achievement Scores
TIC/High Trait Curious
MAP/Low Trait Curious
TIC/Low Trait Curious
MAP/High Trait Curious
Posttest
Retention
Measurement Periods

FIGURE 8

3.2.2.3 Effects of treatment conditions, classes, and pretask state curiosity levels on achievement scores. In order to investigate the hypothesis that high state curious students would perform better on the achievement measures than low state curious students, a 2 x 2 x 2 x 2 analysis of variance with repeated measures on the last factor was calculated. The students were divided into low and high pretask state curiosity groups on the basis of their scores on the 20-item SECS measure administered following the respective introductions to the Weather course for the MAP and TIC groups. The total distribution of these scores was ranked and split at the median, and the MAP-JB, MAP-NL, TIC-JB, and TIC-NL groups were separated out of this distribution. The range of low state curious scores was 48-60; high state curious scores ranged from 61-76. The dependent measures in this analysis were achievement scores on the posttest and retention test.

The means and standard deviations of low and high pretask state curious students in treatment conditions and class groups on the posttest and retention test are reported in Table 14.

Results of the analysis of variance on these data again revealed the significant main effect of measurement periods ($F = 14.54$, $df = 1/54$, $p < .001$) and the significant interaction between class groups and measurement periods ($F = 8.09$, $df = 1/54$, $p < .01$). No other main effects of interactions in this analysis were significant.

In summary, the analyses reported in this section have investigated the effects of anxiety and curiosity, treatment conditions, and class groups on pretest, posttest, and retention test performance. The analyses on pretest scores indicated that students in treatment conditions and trait anxiety and trait curiosity groups were well-matched on levels of prior knowledge of the Weather course objectives. However, there was a tendency for students in the JB class groups to have higher pretest scores than students in the NL class groups; and, therefore, the class groups factors was included in all subsequent analyses. The analyses on achievement gains from pretest to posttest and retention test indicated that students' scores significantly increased from pretest to posttest, and decreased from posttest to retention test. An interaction was found between class groups and measurement periods which indicated that whereas the JB and NL groups did not differ on posttest performance, students in the JB groups performed better than students in the NL groups on the retention test.

Trait anxiety was found to interact with class groups and measurement periods, with low trait anxious students in the JB group increasing in achievement slightly from posttest to retention test, while the other groups, and particularly low trait anxious students in the NL group, decreased in scores from the posttest to retention test. In addition, trait anxiety interacted with treatment conditions, indicating that although high trait anxious students in the MAP and TIC differed little in achievement, low trait anxious students in the TIC group performed better than low trait anxious students in the MAP groups during the posttest and retention test. The analyses which blocked on pretask state anxiety also revealed a significant interaction between state anxiety levels and class groups on the posttest and retention test. Low and high pretask state anxiety students in the TIC-JB group and high pretask state anxiety students in the MAP-NL group performed better than students in the remaining groups.

TABLE 14

Mean Posttest and Retention Test Scores for Low and High Pretask State Curious Students in Treatment Conditions and Class Groups

	Pretest State Curiosity Groups	Achievement Measures: Posttest	Achievement Measures: Retention
MAP-JB	Low (n = 8)		
	Mean	96.00	95.63
	SD	3.30	4.34
	High (n = 7)		
	Mean	95.43	93.43
	SD	5.44	4.65
MAP-NL	Low (n = 6)		
	Mean	99.00	94.17
	SD	1.10	2.04
	High (n = 10)		
	Mean	95.50	91.70
	SD	4.50	8.76
TIC-JB	Low (n = 6)		
	Mean	97.67	98.83
	SD	2.25	2.04
	High (n = 8)		
	Mean	97.75	97.38
	SD	2.55	2.72
TIC-NL	Low (n = 9)		
	Mean	96.44	92.67
	SD	3.36	7.40
	High (n = 8)		
	Mean	97.38	94.63
	SD	3.20	3.16

The analyses which examined the effects of trait and state curiosity, treatment conditions and class groups on posttest and retention test performance revealed an interaction of trait curiosity with treatment conditions and measurement periods on the posttest and retention test. This interaction indicated that whereas the scores of high trait curious students in the TIC condition increased slightly from posttest to retention test, students in the remaining groups performed less well on the retention test than on the posttest.

3.3 Anxiety, curiosity, and attitude results.

3.3.1 Anxiety and curiosity analyses.

3.3.1.1 Effects of treatment conditions, classes, trait anxiety and trait curiosity on pretask state anxiety and state curiosity scores. To investigate the hypothesis that high trait anxious students and high trait curious students in both the MAP and TIC groups would have higher levels of state anxiety and state curiosity, respectively, prior to the course than low trait anxious or low trait curious students, two 2 x 2 x 2 analyses of variance were calculated. In the first analysis, the dependent measure was scores on the 20-item pretask SECS; the dependent measure in the second analysis was scores on the 20-item pretask STAI state anxiety scale. In both analyses, the dependent measure was analyzed as a function of treatment conditions (MAP, TIC), class groups (JB, NL), and levels of either trait anxiety or trait curiosity (low, high). It should be recalled that the pretask state anxiety and state curiosity scales were administered after the respective MAP and TIC introductions to the Weather course. On both pretask scales, students were instructed to respond with how they would feel while learning the course materials.

The means and standard deviations of low and high trait anxious students in treatment conditions and class groups on the pretask state anxiety measure are shown in Table 15.

Results of the analysis of variance on these data indicated that high anxious ($\bar{X}$ = 35.20) students had significantly higher levels of pretask state anxiety than low trait anxious ($\bar{X}$ = 27.29) students ($F = 19.17$, df = 1/54, $p < .001$). The main effect of treatment conditions was also significant ($F = 5.41$, df = 1/54, $p < .02$), with students in the MAP groups ($\bar{X}$ = 29.67) having less anxiety about the learning task than students in the TIC groups ($\bar{X}$ = 33.50). In addition, there was a tendency ($F = 3.31$, df = 1/54, $p < .07$) for students in the JB class groups ($\bar{X}$ = 33.09) to have higher pretask state anxiety than students in the NL class groups ($\bar{X}$ = 30.09). None of the interactions in this analysis approached significance.

The means and standard deviations of low and high trait curious students in treatment conditions and class groups on the pretask state curiosity measure are shown in Table 16.

Results of the analysis of variance on these data indicated that high trait curious ($\bar{X}$ = 63.75) students had significantly higher levels of pretask state curiosity than low trait curious ($\bar{X}$ = 60.40) students ($F = 4.05$, df = 1/54, $p < .05$). The interaction between treatment conditions and class groups was also significant ($F = 4.23$, df = 1/54, $p < .04$), and is shown in Figure 9.

TABLE 15

Mean Pretask STAI State Anxiety Scores for
Low and High Trait Anxious Students in
Treatment Conditions and Class Groups

	Trait Anxiety Groups	Pretask State Anxiety
MAP-JB	Low (n = 7)	
	Mean	28.71
	SD	6.16
	High (N = 8)	
	Mean	33.00
	SD	4.78
MAP-NL	Low (n = 9)	
	Mean	25.67
	SD	4.15
	High (n = 7)	
	Mean	31.29
	SD	5.35
TIC-JB	Low (n = 8)	
	Mean	31.00
	SD	4.69
	High (n = 6)	
	Mean	41.00
	SD	6.96
TIC-NL	Low (n = 9)	
	Mean	27.89
	SD	6.21
	High (n = 8)	
	Mean	35.50
	SD	9.52

TABLE 16

Mean Pretask SECS State Curiosity Scores for Low and High Trait Curious Students in Treatment Conditions and Class Groups

	Trait Curiosity Groups	Pretask State Curiosity
MAP-JB	Low (n = 8)	
	Mean	59.63
	SD	3.02
	High (n = 7)	
	Mean	61.00
	SD	4.00
MAP-NL	Low (n = 8)	
	Mean	60.88
	SD	6.45
	High (n = 8)	
	Mean	66.00
	SD	6.37
TIC-JB	Low (n = 7)	
	Mean	63.71
	SD	7.48
	High (n = 7)	
	Mean	64.57
	SD	7.76
TIC-NL	Low (n = 8)	
	Mean	57.38
	SD	9.09
	High (n = 9)	
	Mean	63.44
	SD	6.13

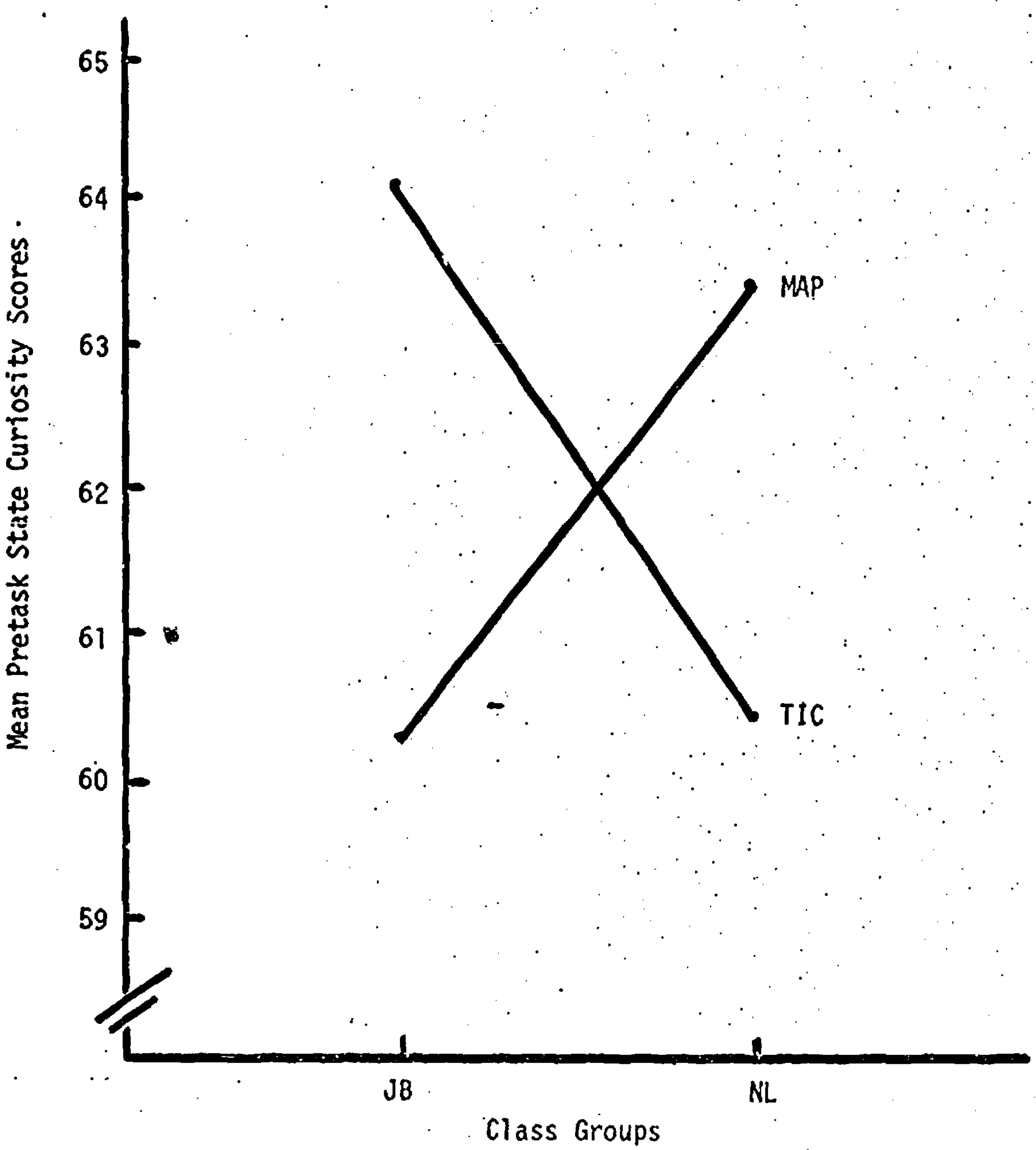
Mean Pretask State Curiosity Scores
65
64
63
62
61
60
59
MAP
TIC
JB
NL
Class Groups

FIGURE 9

This interaction indicated that whereas students in the MAP-JB group had lower pretask state curiosity than students in the MAP-NL group, the reverse was true for students in the TIC groups. No other main effects or interactions were significant in this analysis.

3.3.1.2 Effects of treatment conditions, classes, trait anxiety and trait curiosity on intask state anxiety and state curiosity scores. In order to investigate the hypothesis that high trait anxious students and high trait curious students in both the MAP and TIC groups would have higher levels of state anxiety and state curiosity, respectively, during the course than low trait anxious and low trait curious students, two 2 x 2 x 2 x 2 analyses of variance with repeated measures on the last factor were calculated. The dependent measures in the first analysis were scores on the 7-item STAI state anxiety scales administered to all students halfway through and at the end of the Weather course; in the second analysis the dependent measures were state curiosity scores on the 8-item SECS which was also administered halfway through and at the end of the Weather course. In both analyses, the dependent measures were analyzed as a function of treatment conditions (MAP, TIC), class groups (JB, NL), levels of either trait anxiety or trait curiosity (low, high), and measurement periods (mid, end). The anxiety and curiosity scales administered during both periods instructed students to respond with how they felt while they were learning the course materials they had just completed.

The means and standard deviations of low and high trait anxious students in treatment conditions and class groups on the midtask and end-of-task state anxiety measures are shown in Table 17.

Results of the analysis of variance on these data indicated that students in the MAP ($\bar{X}$ = 9.52) groups had significantly lower levels of state anxiety during the course than students in the TIC ($\bar{X}$ = 11.38) groups (F = 5.78, df = 1/54, $p < .01$). There was also a tendency for high trait anxious ($\bar{X}$ = 11.19) students to have higher state anxiety than low trait anxious ($\bar{X}$ = 9.71) students (F = 3.93, df = 1/54, $p < .07$). No other main effect or interactions in this analysis were significant.

The means and standard deviations of low and high trait curious students in treatment conditions and class groups on the mid-task and end-of-task state curiosity measures are reported in Table 18.

Results of the analysis of variance on these data indicated that high trait curious ($\bar{X}$ = 26.00) students had significantly higher levels of state curiosity during the course than low trait curious ($\bar{X}$ = 23.89) students (F = 6.59, df = 1/54, $p < .025$). In addition, students in the JB ($\bar{X}$ = 25.98) group had significantly higher state curiosity than students in the NL ($\bar{X}$ = 23.91) group (F = 6.38, df = 1/54, $p < .025$). The measurement periods factor was significant (F = 5.92, df = 1/54, $p < .025$), indicating that state curiosity increased from the mid-task period ($\bar{X}$ = 24.44) to the end-of-task period ($\bar{X}$ = 25.32). There was also a tendency for treatment conditions to interact with class groups, which is shown in Figure 10 (F = 3.36, df = 1/54, $p < .10$). This interaction indicated that although there was relatively little difference in the intask state curiosity for the MAP-JB and MAP-NL groups, the TIC-JB group had higher levels of state curiosity than the TIC-NL group. No other main effects or interactions approached significance.

TABLE 17

Mean Intask STAI State Anxiety Scores
for Low and High Trait Anxious Students
in Treatment Conditions and Class Groups

	Trait Anxiety Groups	Intask State Anxiety Mid	Intask State Anxiety End
MAP-JB	Low (n = 7)		
	Mean	9.00	8.86
	SD	1.91	2.61
	High (n = 8)		
	Mean	10.13	10.00
	SD	3.09	3.59
MAP-NL	Low (n = 9)		
	Mean	9.11	9.22
	SD	4.23	3.60
	High (n = 7)		
	Mean	9.71	8.86
	SD	3.30	1.35
TIC-JB	Low (n = 8)		
	Mean	10.25	10.63
	SD	2.82	3.89
	High (n = 6)		
	Mean	13.17	15.17
	SD	2.93	3.97
TIC-NL	Low (n = 9)		
	Mean	9.33	8.78
	SD	2.24	2.59
	High (n = 8)		
	Mean	11.88	11.63
	SD	2.53	4.21

TABLE 18

Mean Intask SECS State Curiosity Scores
for Low and High Trait Curious Students in
Treatment Conditions and Class Groups

	Trait Curiosity Groups	Intask State Curiosity Mid	End
MAP-JB	Low (n = 8)		
	Mean	24.63	23.50
	SD	1.41	1.77
	High (n = 7)		
	Mean	25.86	27.14
	SD	2.97	2.73
MAP-NL	Low (n - 8)		
	Mean	23.38	24.25
	SD	5.34	4.37
	High (n = 8)		
	Mean	24.75	26.13
	SD	5.37	4.88
TIC-JB	Low (n = 7)		
	Mean	26.14	27.57
	SD	4.06	3.55
	High (n = 7)		
	Mean	25.71	27.86
	SD	2.56	3.44
TIC-NL	Low (n = 8)		
	Mean	21.88	22.88
	SD	3.52	3.80
	High (n = 9)		
	Mean	23.78	24.22
	SD	2.95	2.22

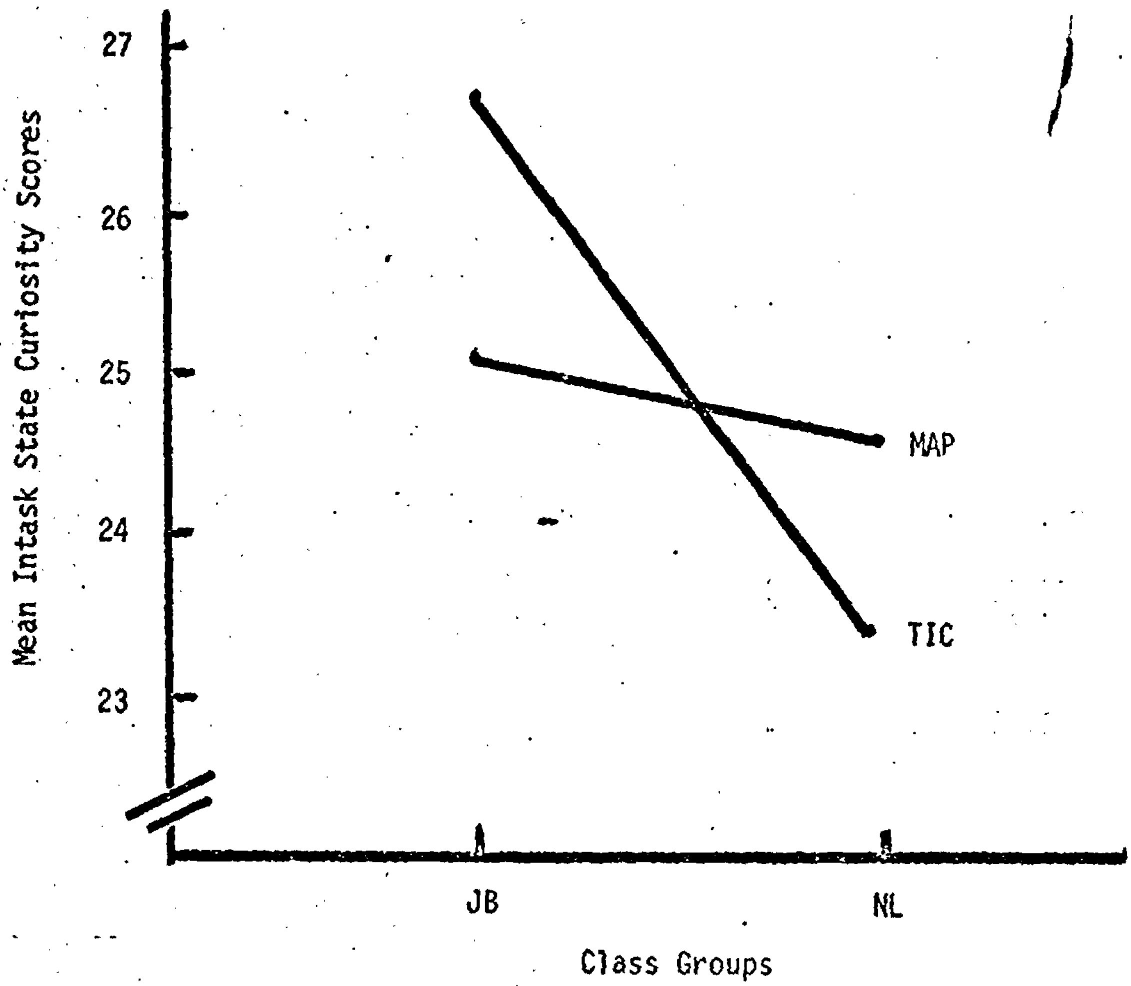
27
26
25
24
23
Mean Intask State Curiosity Scores
MAP
TIC
JB
NL
Class Groups

FIGURE 10

3.3.1.3 Effects of treatment conditions, classes, and pretask state curiosity on intask state anxiety scores. To investigate the hypothesis that high state curious students in both the MAP and TIC groups would have lower levels of state anxiety during the course than low state curious students, a 2 x 2 x 2 x 2 analysis of variance with repeated measures on the last factor was calculated. The independent variables in this analysis were treatment conditions (MAP, TIC), class groups (JB, NL), levels of pretask state curiosity (low, high), and measurement periods (mid, end). The dependent measures were scores on the 7-item STAI state anxiety scales administered halfway through and at the end of the Weather course.

The means and standard deviations of low and high pretask state curiosity students in treatment conditions and class groups on the mid-task and end-of-task state anxiety measures are reported in Table 19.

Results of the analysis of variance on these data indicated, as in the trait anxiety analysis, that students in the MAP groups had significantly lower levels of state anxiety during the course than students in the TIC groups ($F = 4.98$, $df = 1/54$, $p < .05$). In addition, there was a tendency for class groups to interact with levels of pretask state curiosity ($F = 3.96$, $df = 1/54$, $p < .06$). This interaction, shown in Figure 11, indicated that although high state curious students in the NL group tended to have lower levels of state anxiety during the course than low state curious students, for students in the JB group, the reverse was true. No other main effects or interactions in this analysis approached significance.

3.3.2 Attitude analyses.

3.3.2.1 Effects of treatment conditions, classes, trait anxiety and trait curiosity on attitude scores. To determine whether attitude toward the instructional method differed for students in the treatment conditions (MAP, TIC), class groups (JB, NL), and trait anxiety or trait curiosity groups (low, high), two 2 x 2 x 2 analyses of variance were calculated. The dependent measure in both analyses was scores on the attitude scale administered to all students immediately before the course posttest. In the first analysis, the dependent variable was examined as a function of trait anxiety levels, treatment conditions, and class groups; in the second analysis, it was examined as a function of trait curiosity, treatment conditions, and class groups.

The means and standard deviations of low and high trait anxious students in treatment conditions and class groups on attitude scores are shown in Table 20.

Results of the analysis of variance on these data indicated that students in the MAP ($\bar{X} = 66.71$) groups had significantly higher positive attitudes toward the instructional method than students in the TIC ($\bar{X} = 61.19$) groups ($F = 7.99$, $df = 1/54$, $p < .01$). The interaction between treatment conditions, class groups, and trait anxiety levels was also significant ($F = 5.53$, $df = 1/54$, $p < .02$) and is shown in Figure 12. This interaction indicated that whereas attitude scores were lower for low trait anxious students than for high trait anxious students in the MAP-JB group, and TIC-NL students had relatively the same attitude scores regardless of their trait anxiety levels. No other main effects or interactions in this analysis were significant.

TABLE 19

Mean Intask STAI State Anxiety Scores for Low and High Pretask State Curious Students in Treatment Conditions and Class Groups

	Pretask State Curiosity Groups	Intask State Anxiety Mid	End
MAP-JB	Low (n = 8)		
	Mean	8.50	9.00
	SD	1.41	2.39
	High (n = 7)		
	Mean	10.86	10.00
	SD	3.13	3.92
MAP-NL	Low (n = 6)		
	Mean	10.50	10.00
	SD	3.08	2.68
	High (n = 10)		
	Mean	8.70	8.50
	SD	4.08	2.80
TIC-JB	Low (n = 6)		
	Mean	9.83	11.67
	SD	2.32	4.63
	High (n = 8)		
	Mean	12.75	13.25
	SD	3.20	4.46
TIC-NL	Low (n = 9)		
	Mean	10.56	10.00
	SD	3.32	3.04
	High (n = 8)		
	Mean	10.50	10.25
	SD	1.85	4.43

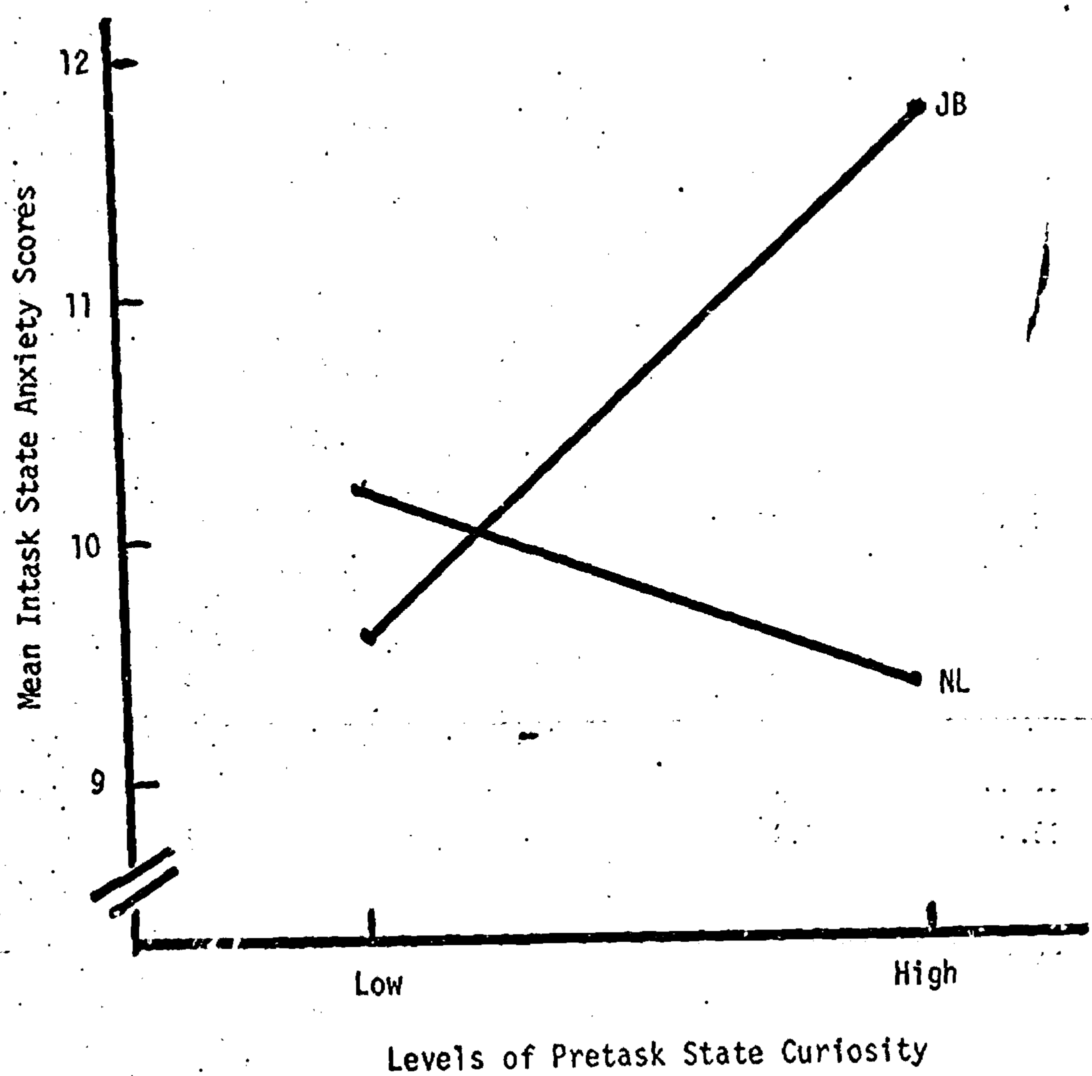
12
11
10
9
Mean Intask State Anxiety Scores
JB
NL
Low
High
Levels of Pretask State Curiosity

FIGURE 11

TABLE 20

Mean Attitude Toward Instructional Method
Scores for Low and High Trait Anxious Students
in Treatment Conditions and Class Groups

	Trait Anxiety Groups	Attitude
MAP-JB	Low (n = 7)	
	Mean	68.43
	SD	6.80
	High (n = 8)	
	Mean	66.00
	SD	7.96
MAP-NL	Low (n = 9)	
	Mean	63.00
	SD	12.93
	High (n = 7)	
	Mean	70.57
	SD	5.68
TIC-JB	Low (n = 8)	
	Mean	59.50
	SD	4.72
	High (n = 6)	
	Mean	66.50
	SD	4.55
TIC-NL	Low (n = 9)	
	Mean	60.67
	SD	6.95
	High (n = 8)	
	Mean	59.50
	SD	4.96

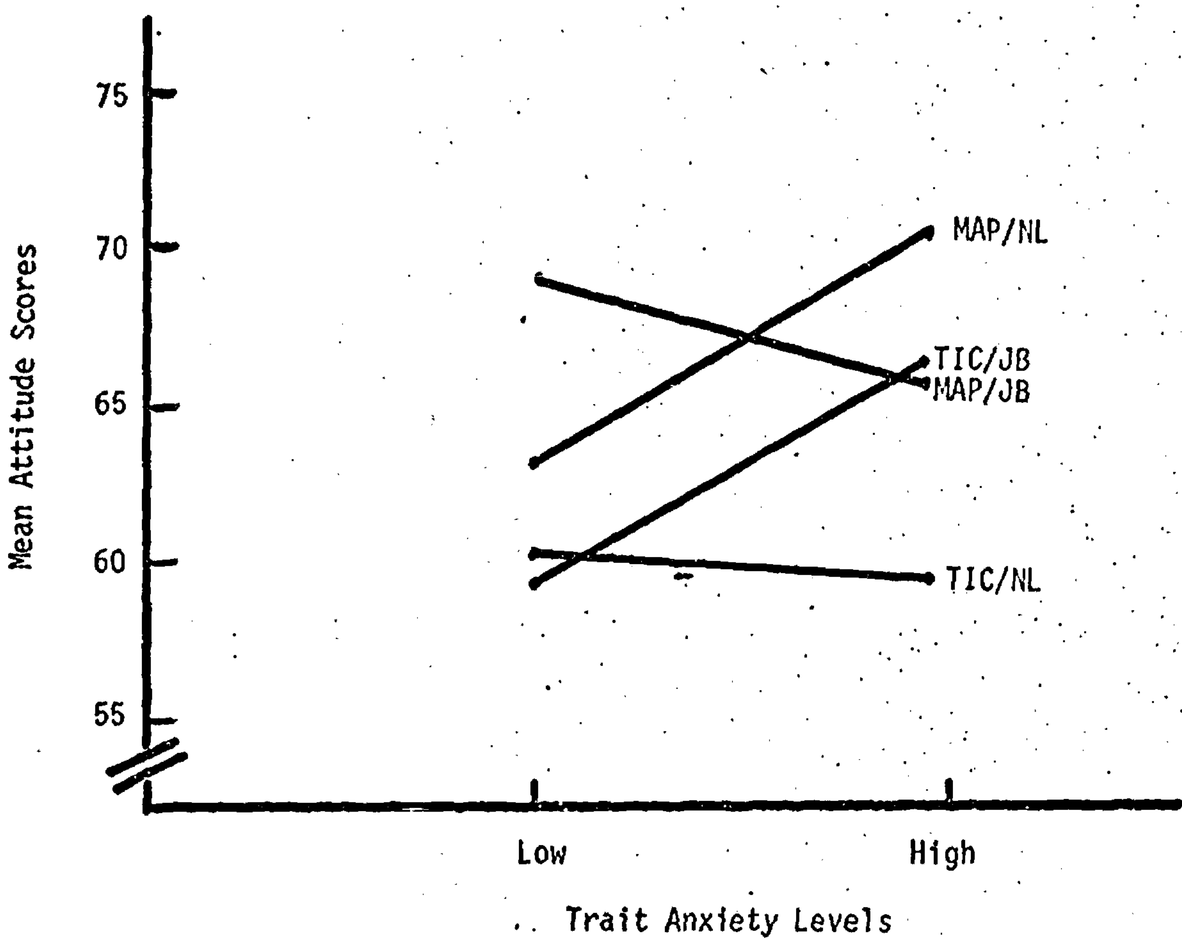
Mean Attitude Scores
75
70
65
60
55
MAP/NL
TIC/JB
MAP/JB
TIC/NL
Low
High
Trait Anxiety Levels

FIGURE 12

The means and standard deviations of low and high trait curious students in treatment conditions and class groups on attitude scores are shown in Table 21.

Results of the analysis of variance on these data also indicated that students in the MAP ($\bar{X}$ = 66.71) groups had significantly higher attitude toward the instructional method than students in the TIC ($\bar{X}$ = 61.19) groups ($F = 7.24$, $df = 1/54$, $p < .01$). No differential effects were found for class groups or trait anxiety levels.

In summary, the analyses reported in this section have examined the effects of trait anxiety, trait curiosity, treatment conditions, and class groups on state anxiety, state curiosity, and attitude scores. As predicted, level of trait anxiety was significantly related to pretask and somewhat related to intask state anxiety scores, with high trait anxious students having higher state anxiety than low trait anxious students. Students in the MAP groups were also found to have significantly lower state anxiety after the introduction and during the Weather course than students in the TIC groups. In addition, students in the JB class groups tended to have higher state anxiety during the course than students in the NL class groups. With respect to the curiosity analyses, high trait curious students had significantly higher state curiosity throughout the experimental session, as predicted, then low trait curious students. The curiosity scores of JB students were also found to be significantly higher than those of the NL students during the course, and the curiosity scores of all students increased from halfway through the course to the end of the course. Furthermore, dependent on treatment conditions, class groups, and trait curiosity conditions, subjects were found to respond with differential state curiosity scores during the course. The analyses on the attitude scale data revealed that students in the MAP groups had higher attitudes toward the instructional method than students in the TIC groups. Attitude scores were also found to differ dependent on treatment conditions, class groups, and trait anxiety levels.

3.4 Learning time results. In order to investigate the hypothesis that students in the MAP group would complete the Weather course in less time than students in the TIC group, a one-tailed t-test for the difference between a sample mean and population mean was calculated (Bruning and Kintz, 1968). The mean number of hours the MAP students spent in the course was 15.64, with a standard deviation of 4.43, compared to a fixed time of 22 hours for students in the TIC group. Results of the t-test revealed that MAP students completed the course in significantly less time than students in the TIC group ($t = 7.85$, $df = 30$, $p < .001$). The time difference between the two groups represented a 29% time savings for the MAP versus TIC group. Of the 15.64 hours which the MAP students spent on the Weather course materials, an average of 4.40 hours were spent on the adjunct questions.

To determine whether students in the MAP-JB and MAP-NL groups differed significantly in total time to complete the Weather course, a one-way analysis of variance was calculated. Students in the MAP-JB group completed the course in a mean time of 16.51 hours (SD = 4.75), and students in the MAP-NL group completed the course in a mean time of 14.66 hours (SD = 2.13). Results of the analysis of variance on these data were not significant.

TABLE 21

Mean Attitude Toward Instructional Method
Scores for Low and High Trait Curious Students
In Treatment Conditions and Class Groups

	Trait Curiosity Groups	Attitude
MAP-JB	Low (n = 8)	
	Mean	65.75
	SD	5.52
	High (n = 7)	
	Mean	68.71
	SD	9.11
MAP-NL	Low (n = 8)	
	Mean	65.50
	SD	11.43
	High (n = 8)	
	Mean	67.13
	SD	10.91
TIC-JB	Low (n = 7)	
	Mean	63.43
	SD	5.13
	High (n = 7)	
	Mean	61.57
	SD	6.55
TIC-NL	Low (n = 8)	
	Mean	59.88
	SD	5.19
	High (n = 9)	
	Mean	60.33
	SD	6.84

4. DISCUSSION

The major findings of the present study may be summarized as follows. All measures administered during the experimental session (i.e., pretest, STAI scales, OTIM, SECS scales, attitude scale) were found to have acceptable reliability coefficients. The hypothesis that students in the MAP group would complete the course in less time and perform equally as well on the posttest and retention test as students in the TIC group was confirmed. Students in the MAP group were found to complete the Weather course in 29% less time than students in the TIC group. In addition, the differences in the performance of the MAP and TIC groups on the posttest and retention test were not significant, although the performance of students in both groups decreased from the posttest to retention test. The learning time findings are consistent with previous research indicating significant time savings for individualized, multi-media instructional groups compared to traditional instructor classroom groups (e.g., Federico, 1971; Anderson and Hagin, 1971; Wood, 1971). Similarly, previous research comparing the performance of multi-media and traditional classroom groups has generally indicated (a) no significant differences between these groups on immediate tests of course objectives (e.g., DeCecco, 1968; Orr, 1968; Whitted, Weaver and Foley, 1966), and (b) no significant differences (e.g., Ashford, 1968) or superiority of multi-media groups on retention tests, particularly when adjunct questions are used along with the multi-media materials (e.g., Rothkopf, 1970).

The prediction that students in the MAP group would have higher levels of state curiosity during the learning task than students in the TIC group was only partially supported with the present data. That is, MAP students in the NL flight group were found to have higher pretask and intask state curiosity scores than TIC students in the NL flight group. For MAP and TIC students in the JB flight groups, on the other hand, the reverse was found. Possible factors which may have accounted for these differences between the NL and JB flight groups will be discussed following this summary of major findings. Of interest in this context, however, was the finding that although MAP students were not generally found to have higher state curiosity during the learning task than TIC students, MAP students were found to have lower levels of state anxiety while learning the Weather course than TIC groups. Thus, whereas MAP and TIC groups were comparable in overall levels of state curiosity or interest in the Weather course materials, students in the MAP group reported lower levels of state anxiety while learning the materials than students in the TIC group.

The hypothesis that high state curious students in both the MAP and TIC groups would have lower levels of state anxiety and perform better on the achievement measures than low state curious students was generated in order to replicate previous research indicating (a) an inverse relationship between state curiosity and state anxiety, and (b) a positive relationship between state curiosity and performance (Leherissey, 1972). Findings with the present data indicated that in the NL flight groups only high state curious students tended to have lower levels of state anxiety while learning the course materials, while a positive relationship between state curiosity and state anxiety was found for students in the JB flight groups. For the total group, no significant negative relationships were found between these measures (i.e., *r* ranged from .01 to .16 between these state measures). In addition, when students in both MAP and TIC groups were blocked on levels of pretask state curiosity, the present data did not support the predicted positive relationship between state curiosity and performance (posttest, retention). The correlational data, however, indicated a positive relationship between (a) midtest state curiosity and posttest performance for the total group; (b) midtask state curiosity and retention test performance for the TIC group; and (c) end-of-task state curiosity and retention test performance for the TIC group. These inconsistent findings appear to be attributable to task-specific and flight group-specific factors, both of which will be discussed later in this section.

With respect to the prediction that high trait anxious students and high trait curious students in both the MAP and TIC groups would have higher levels of state anxiety and state curiosity, respectively, during the course than low trait anxious or low trait curious students, the present data was supportive. High levels of trait anxiety were significantly related to high levels of pretask state anxiety and somewhat related to high levels of intask state anxiety; and, as predicted, high trait curious students had significantly higher levels of both pretask and intask state curiosity than low trait curious students. These findings are consistent with previous research on the relationships between anxiety and curiosity traits and states (Spielberger, et al, 1970; Leherissey, 1972). The concurrent validity findings also supported the trait-state curiosity relationships, in that moderately high positive correlations were found between trait curiosity (OTIM) scores and state epistemic curiosity (SECS) scores.

Also of interest in the present study was a comparison of the attitudes reported by MAP and TIC groups toward the instructional method following their completion of the Weather course. The analyses directed at this question indicated that students in the MAP group had significantly higher attitudes than students in the TIC group. Furthermore, dependent on their levels of trait anxiety, treatment conditions, and flight class groups, students reported differential attitudes toward the instructional method. Highest attitude scores were found for high trait anxious students in the MAP-NL group and low trait anxious students in the MAP-JB group; lowest attitude scores were found for low trait anxious students in the TIC-JB and TIC-NL groups, and high trait anxious students in the TIC-NL group.

In order to explore further the specific differences between the MAP and TIC groups in their respective attitudes toward the instructional method, an item analysis was performed on these data. With respect to the items of particular interest, students in the MAP group did not differ from students in the TIC group in feeling that they had enough individual attention, their questions were answered, and the method of instruction was not too mechanical. Neither group felt isolated or alone, nor did either group feel frustrated by the instructional situation. In addition to the above similarities, both groups indicated that the method of instruction did not decrease their learning rates, that the films and slides were not particularly motivating, and that they did not feel they had their own instructor during the respective instructional sessions.

With respect to the differences between the MAP and TIC groups, the MAP group, as expected, did not feel that their presentations repeated assigned readings, whereas the TIC group did. The MAP group felt strongly that they had enough time to study the materials on their own, and the TIC group did not feel that they had enough time. The MAP group also expressed feelings of wanting to do their best work during the instruction, while the TIC group indicated that they only somewhat felt like they wanted to do their best. Although neither group felt strongly that the method of material presentation made them want to work harder, the item means were lower for the TIC than MAP group. In addition, the MAP group felt that concepts and rules were easy to understand utilizing the instructional method, whereas the TIC group felt that they had no control over how the material was presented and that the method of instruction was not very interesting. As indicated in the other attitude scale analyses, the JB and NL groups differed in their responses to some of the items. The NL group, in general, responded more positively than the JB in the MAP condition, but the JB group responded more positively than the NL group in the TIC condition.

The attitudes of the two ATC Weather course instructors toward the MAP method were also generally positive. When asked to list the three or four things they liked best about the MAP method of instruction, both ATC instructors listed the advantages of self-paced instruction for UPT, in that students could schedule their course time to take advantage of all available flight training time. In addition, both instructors felt that the MAP method had the advantage of allowing students to repeat or review any particularly difficult materials as they desired. The instructors also liked (a) the use of a variety of narrator voices for holding student interest on the MAP sound/slide materials; (b) the fact that in the development of the multi-media materials there was the insurance that no important concepts were omitted; and (c) the reduced demand on instructor time spent in reteaching the student due to the quality of the MAP materials and instructional method.

The features the ATC instructors liked least about the MAP method were that they felt they had a lack of contact with MAP students and thus did not know the progress of these students in the course. They further felt that their current roles were complicated by the additional test administration and record keeping procedures required for the MAP course administration. In terms of student learning with the MAP method, one instructor felt that a self-paced program may not be good for those students who have difficulty disciplining themselves, and that the method may only expose the student to course concepts rather than insuring that he comprehends these concepts.

In general, however, the instructors felt the MAP approach could be implemented within the UPT program after further validation. They suggested that this implementation would be enhanced by (1) extending the available learning center hours to 15 rather than 10 per day; (2) establishing regular hours when instructors could interview MAP students; (3) establishing a specific final testing schedule for MAP students to lighten the administrative burdens of this type of self-paced program; and (4) providing MAP students with additional study guide materials, which would parallel the learning programs to assist the student in note-taking or home study.

Several other findings of interest in the present study are related to performance differences. First, although students within the JB and NL flight class groups were chosen for the MAP or TIC conditions on the basis of matched pretest scores, the analyses on pretest performance indicated a tendency for the JB group to have higher pretest scores than the NL group. Thus, all subsequent analyses blocked on the flight class group factor. Second, trait anxiety was found to interact with flight groups on both the pretest and posttest/retention test, which generally indicated that high trait anxiety facilitated the performance of JB groups on pretest, posttest and retention test, whereas it tended to debilitate performance on these measures for the NL groups. In addition, high trait anxiety facilitated performance for MAP students on the posttest/retention test relative to low trait anxiety, whereas level of trait anxiety had no effect on posttest/retention test scores for TIC students. Third, levels of pretask state anxiety interacted with both treatment conditions and flight class groups, indicating that high levels of state anxiety were debilitating for MAP-JB and TIC-NL groups, but facilitating for the MAP-NL and TIC-JB groups. Finally, trait curiosity levels also interacted with flight class groups on pretest scores, indicating that high levels of curiosity facilitated pretest performance for students in the JB group, whereas low levels of curiosity were facilitative for students in the NL group. On the posttest and retention test, trait curiosity was debilitating for MAP students, but facilitating for TIC students, with low trait curiosity being equally facilitating for both MAP and TIC students on the posttest and retention test.

The above findings are generally inconsistent with previous anxiety research which has indicated either no relationship between trait anxiety and performance (e.g., Leherissey, et al, in press; Leherissey, et al, 1971) or an inverse relationship between trait or state anxiety and performance (e.g., Sieber, 1969; Sieber and Kameya, 1967; Leherissey, 1972; Spielberger, et al, 1970). The present anxiety findings, however, were dependent on differential flight class group and treatment condition factors, making interpretation difficult. Similarly, the trait curiosity and performance findings were also a function of both flight class groups and treatment conditions, with inconsistent relationships being found. Some of the possible reasons for the flight class group differences are given below.

First, it was noted that the JB group differed from the NL group in that they performed better on the course pretest which assessed prior knowledge of the Weather course objectives. The Weather course instructors observed that the JB flight commanders and section leaders seemed to emphasize academics more than the commanders and section leaders in the NL group, and this may have contributed in part to the flight group pretest performance disparity. This difference in flight group academic emphasis may also have contributed to the finding that the scores of students in the JB group remained relatively the same between posttest and retention test, while for students in the NL group, scores decreased from the posttest to retention test.

Other factors which may partially account for the differential class group and treatment condition interactive findings on the state anxiety, state curiosity, and attitude score analyses, relates to the fact that there were instructor differences for the JB and NL groups in the TIC condition. The more time the JB instructor spent on the course introduction may have contributed to higher pretask and intask state curiosity scores and end-of-course attitude scores for TIC-JB students compared to TIC-NL students. In addition, the greater emphasis on academics within the JB group may also have made it a more arousing condition, which is supported by the data indicating higher levels of both curiosity and anxiety in the JB groups.

It still remains to be explained, however, why JB and NL students differed in the MAP condition, where more comparable task and instructor variables were present. Some anecdotal data collected by the MAP experimenters may help elucidate the findings that the NL group, in general, performed most consistently with respect to the experimental hypotheses. For example, it was noted that from the beginning of the experiment the NL group seemed more enthusiastic and interested in both the Weather course materials and MAP method than the JB group. Possible factors contributing to this initial, and continuing, difference may have been that (a) the flying schedules of the NL group during the first week were in the afternoon, making the NL students more rested and attentive during their morning MAP sessions; and (b) the JB group, whose flying schedules were in the morning the first week, were tired and less attentive during their afternoon MAP sessions; and (c) although both the NL and JB groups had missed a considerable amount of flying time due to bad weather conditions and were forced to make up flying hours, the JB group was generally further behind in their flying schedules. Perhaps because of this latter factor, MAP students in the JB group were less inclined to use their free time to finish up the course materials early, and they tended to report to the learning center in the afternoon, as a group, rather than spreading their scheduled times throughout the day. By reporting as a group, the JB students often overloaded available media devices and thus experienced hardware problems not felt by the MAP-NL students. All of these factors, therefore, may have led to the tendency for MAP-JB students to have lower attitudes, longer instructional times, higher state anxiety, lower state curiosity, and lower performance scores than MAP-NL students. Furthermore, it seems reasonable to suggest that the flight class group differences may have not only led to inconsistencies in the present findings, but may also have attenuated the relative differences between the MAP and TIC conditions.

In conclusion, the present study supported the major hypotheses of reduced training time and comparable performance on the posttest and retention test for students in the MAP condition relative to the TIC condition. Suggestive of the advantages of the multi-media, individualized training course for academic pilot training are the findings of lower state anxiety and higher attitudes for MAP than TIC students. The absolute benefits of adjunct questions within the MAP condition cannot be determined with the present data, but the concept appears to offer a fruitful research direction for future studies aimed at optimizing the instructional process. In addition, the present study points out the importance of considering student motivation (curiosity, anxiety, attitude) engendered by the instructional method when assessing the effectiveness of differential instructional treatments. The eventual use of this type of data in selectively assigning students to instructional methods also represents a worthwhile research goal. Finally, the positive attitudes of both UPT students and instructors toward the MAP method indicate the feasibility of this approach for enhancing academic pilot training.

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