A COMPARISON OF TEAMS-GAMES-TOURNAMENTS(TGT) AND TRADITIONAL CLASSROOM METHODS IN HIGH SCHOOL BIOLOGY

by

Rebecca Ross Dechow

Dissertation submitted to the Faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree
Doctor of Education

APPROVED:

Thomas G. Teates, Chairman

Arthur L. Buikema, Jr.

Lawrence Cross

Patricia Kelly

David Michael Moore

May, 1983
Blacksburg, Virginia

A COMPARISON OF TEAMS-GAMES-TOURNAMENTS (TGT) AND TRADITIONAL CLASSROOM METHODS IN HIGH SCHOOL BIOLOGY

Rebecca Ross Dechow

(ABSTRACT)

Since 1970, researchers at Johns Hopkins University have studied the effects of a game technique called the teams-games-tournament method on the achievement scores, attitudes, and classroom process of elementary and junior high students. Their findings raised many questions about the applicability of team-games to affect achievement at the high school level or in subject areas other than math and English. In 1980, the National Science Foundation allocated funds for the creation of TGT materials for seventh-grade science, even though research of its effectiveness for science courses had not been conducted.

This study was designed to provide answers to the following questions: Would high school students playing teams-games-tournaments have greater academic achievement in a high school biology course than students in classes using traditional classroom methods? Would high school students in TGT classes have greater retention of knowledge after a delayed period of time than those students in classes using traditional classroom methods? Would high school students in TGT classes have more positive attitudes toward the subject of biology than students in classes using traditional classroom methods? Would high

school students like TGT better as a means for studying chapter material than traditional methods?

Eight biology classes were involved in the seven-week treatment period. Analysis of variance was used to compare control and experimental groups for (1) pre-test cognitive knowledge, (2) post-test cognitive knowledge, (3) delayed post-test cognitive knowledge, (4) pre-test attitudes towards biology, and (5) post-test attitudes towards biology. Analysis of covariance was computed using I.Q. and pre-test scores as covariates for post-test cognitive means and delayed post-test cognitive means. A dependent t-test was computed for attitudes of experimental classes towards team-games.

TGT had no significant effect on the biology achievement scores or attitudes towards biology of high school students in this study. Experimental classes did like team-games and sustained their attitudes towards them for the duration of the study.

TO

and

ACKNOWLEDGMENTS

It is a pleasure to express my appreciation to those who have assisted me in various ways so that this study could be brought to completion. I am especially grateful to the members of my doctoral committee: Dr. Art Buikema, Dr. Lawrence Cross, Dr. Patricia Kelly, Dr. David Michael Moore, and Dr. Thomas G. Teates. A special note of thanks goes to Dr. Lawrence Cross who assisted with analysis of statistical data, Dr. Patricia Kelly, who offered writing suggestions, and to Dr. Thomas Teates, who has served as adviser to me and chairman of the committee. Each gave particular encouragement throughout the endeavor.

Acknowledgment is made to the Roanoke County School Administration for special consideration given to me to undertake the study in public schools. My principal at Cave Spring High, , was most helpful. I am deeply indebted to the two teachers who cooperated with me in the two year study - and .

My friend, , deserves special mention for her assistance in preparation of materials and the typing of information.

Finally, I am indebted to my husband, , for his patience, encouragement, assistance, and understanding throughout all phases of the study.

TABLE OF CONTENTS

Page

Abstract ii

Dedication iv

Acknowledgments v

Table of Contents vi

List of Tables ix

List of Figures x

Chapter

I INTRODUCTION

Teams-Games-Tournaments 2

Purpose of the Study 7

Definition of Terms 8

II REVIEW OF THE LITERATURE

Creation and Research of the TGT Method 13

Theoretical Models Associated with TGT . . . 20

Summary 22

III METHODOLOGY

Description of Subjects 24

Basic Description of the TGT Method 25

Procedure 27

Instruments Used 36

Collection and Treatment of the Data 38

Page

IV RESULTS OF THE STUDY

Cognitive Achievement Data 42

Attitude Data 50

Summary 53

V DISCUSSION, FINDINGS

Discussion 55

Findings 59

BIBLIOGRAPHY 61

APPENDICES

A. Cognitive Pre-Test 66

B. Cognitive Post-Test 73

C. Biology Attitude Test 80

D. Team Games Attitude Test 82

E. Lesson Plans for the Seven Week Study 84

F. Objectives for Chapters 12, 13, 14 94

G. Prorating Score Sheet for TGT 102

H. Team Summary Sheet for TGT 104

I. Tournament Score Sheet for TGT 106

J. Game Score Sheet for TGT 108

K. Sample Tournament Score Sheet 110

L. Team Summary Sheet Sample 112

Page

M. Sample Newsletter 114

N. Results of 1980-81 Pilot Study 116

VITA 129

LIST OF TABLES

Table		Page
1.	Settings of Ten TGT Studies	3
2.	Teams-Games-Tournaments Effects on Achievement and Attitudes	5
3.	Team Assignments for a Class	29
4.	Team Summary Table	35
5.	Summary of Means for All Tests	43
6.	Pre-Test of Cognitive Knowledge: Analysis of Variance	44
7.	Chapters Post-Test of Cognitive Knowledge: Analysis of Variance	46
8.	Chapters Post-Test: Analysis of Covariance	47
9.	Delayed Post-Test: Analysis of Variance	48
10.	Delayed Post-Test: Analysis of Covariance	49
11.	Pre-Test of Attitudes Towards Biology: Analysis of Variance	51
12.	Post-Test of Attitudes Towards Biology: Analysis of Variance	52
13.	Attitudes Towards Team Games	54

LIST OF FIGURES

Figure		Page
1.	Assignment of Students to Tables and Leagues	32
2.	Time Schedule For Administration of Tests	39

Chapter 1

INTRODUCTION

The motivation of individuals to want to learn is and has always been a challenge to teachers. In American schools and universities, new techniques are constantly being created and formulated to generate enthusiasm and interest in academic subjects. One area which has greatly expanded since 1960 has been the use of games and gaming techniques as a way to promote learning. In the early 1960's, so many new "simulation" games had been created that by 1973 Zuckerman and Horn published a guide (Zuckerman and Horn, 1973) which listed over 3000 such games for different fields. At the same time, non-simulation games and team games were being created for use in the classroom. In 1959, James Coleman at Johns Hopkins University called for educators to use groups and team competitions among adolescents as a way to generate enthusiasm and enhance learning (Coleman, 1959).

In response, David L. DeVries, Keith Edwards, Robert L. Slavin and I. T. Mescon at Johns Hopkins began in the 1970's to seriously research the effects of team game competition on achievement scores, attitudes, and classroom process. Their findings showed mixed results and raised many questions about the applicability of team games to affect achievement at the high school level or in subject areas other

than math and English. Using team games in subject fields such as science was left unexplored and open for research. This is the area selected for study in this dissertation.

Teams-Games-Tournaments

Working at the Center for the Social Organization of Schools at Johns Hopkins University in Baltimore, Maryland, DeVries and his associates first created their own team game technique, which they called the teams-games-tournament method. The teams-games-tournament method involves teams of four or five students competing against members of other teams at tournament tables in academic games at least once a week or more for 30-45 minutes. Tournament tables and team membership are set up according to ability level, and the teams have a team practice session the day before any tournament is played. After a tournament, points and scores are recorded and a newsletter is published to show team standings.

From 1970 to 1976, DeVries and associates at Johns Hopkins conducted ten studies of the effects of teams-games-tournaments (TGT) versus alternative methods of instruction on cognitive academic achievement, student attitudes towards school, peer-interaction and mutual concern. This researcher examined the ten studies of TGT and its effects on cognitive and affective processes and found several areas which merited further study. First, none of the ten research studies was in the subject area of science (see Table 1). However, in 1980, John Hopkins developed TGT materials for junior high life science under

Table 1

Settings of Ten TGT Studies

Study	Subject Area	Grade Level	Length (Weeks)	Number of Students	Major Reports
1	Math	7	9	96	Edwards, DeVries & Snyder, 1972
2	Math	7	4	110	Edwards & DeVries, 1972
3	(a)Math (b)Social Studies	7	12	128	Edwards & DeVries, 1974
4	Math	7	10	299	Hulten & DeVries, 1976
5	Social Studies	10-12	12	191	DeVries, Edwards & Wells, 1974
6	Language Arts	3	6	60	DeVries & Mescon, 1975
7	Language Arts	3	6	53	DeVries, Mescon & Shackman, 1975a
8	(a)Reading Vocab. (b)Verbal Analogies	3	5	53	DeVries, Mescon & Shackman, 1975b
9	Language Arts	7-9	10	1,742	DeVries, Lucasse & Shackman, 1978
10	Social Studies	7-9	10	57	Slavin, 1977

(From: "Teams, Games, Tournaments (TGT): Review of Ten Classroom Experiments" by David L. DeVries, Fall, 1978, p. 32).

a grant from the National Science Foundation. A research study was begun in 1982 by Marshall Leavey of Johns Hopkins to investigate the effectiveness of TGT in junior high life science, but results have not been analyzed or published at the time of this writing. Second, only one study of TGT was conducted at the high school level (see Table 1). The high school TGT classes in social studies showed a "marginal" gain ($p < .10$) over control classes on a curriculum specific test (DeVries, 1978, p. 1). TGT was found to be most successful in math, language arts, reading and vocabulary at the elementary and junior high level (see Table 2). When this researcher contacted Dr. Robert Slavin, he expressed an interest in using TGT in high school science classes in the future, even though no research studies have been conducted to find out if TGT is effective in science courses.

A third area of concern found in some of the TGT studies was the fact that teachers of control groups were given the same objectives and curriculum materials as the experimental groups, but were not held to the same lesson plans or instructional schedule (Slavin, 1980, p. 334). Fourth, there was an inconsistency concerning the use of worksheets by both experimental and control classes. Some studies (Numbers 1, 6, 7, 8, 9, 10 of Table 1) reported that both experimental and control groups used the same worksheets, and other studies did not. Research design suggests that all teachers should follow the same instructional schedule, and the same worksheets should be used by all classes so that neither experimental or control groups have an unfair advantage. Fifth, no attempt was made in any of the studies to measure retention

Table 2

Teams-Games-Tournaments Effects on Achievement and Attitudes

Study	Achievement: Curriculum Specific	Achievement: Standardized	Mutual Concern	Attitudes Toward School
1-Math	+	+	---	---
2-Math	+	---	+	+
3-a) Math	+	---	+	+
b) Social Studies	0	---		
4-Math	---	+	---	0
5-Social Studies	(+)	0	+	+
6-L. Arts	+(2/6)	+	0	0
7-L. Arts	+(3/6)	+	0	0
8a) Vocabulary	+	---		
b) Analogies	+	---	---	---
9-L. Arts	+	0	+	0
10-Social Studies	0	0	+	0

\+ = TGT students gained sign. more than control (p = .05)
(+) = TGT students gained marginally more than control (p = .10)
--- = variable not measured
0 = no sign. difference

(From: "Teams-Games-Tournaments (TGT) = Review of Ten Classroom Experiments" by David L. DeVries, Fall, 1978, p. 33)

of knowlege after a delayed period of time. Sixth, significant achievement differences between experimental and control groups were not seen as frequently when standardized tests were used. Curriculum specific tests were much more successful in detecting differences in treatments.

An analysis of the ten studies indicated that with studies 1,2, and 3, items for one test were taken from the Stanford Achievement Test, but a divergent solutions test developed by Edwards and DeVries was also used for which, according to Edwards, they had no reliability or validity data (Edwards and DeVries, 1972, p. 6), a fact which casts doubt on the results of the studies. An arithmetic computational subtest of the Stanford Achievement Test was used for Study 4, but no reliability estimate was given. The reliability estimates of researcher-made tests of studies 5,6,7, and 8 were given. However in studies 6 and 7, which both used researcher-made subtests of the Hoyum-Saunders Elementary English Test, experimental students did not perform significantly better than control students on all phases of testing. In Study 6, students performed significantly better on two out of six subtests; in Study 7, three out of six. The researchers themselves noted that standardized tests may not detect changes in student achievement because of "content sampling limitations" of standardized tests, because of a weakness of TGT to have an impact on a wide range of skills (DeVries, Lucasse, and Shackman, 1980, p. 14), or because standardized tests are insensitive to methods designed to increase specific skills (DeVries and Mescon, 1975, p. 16).

Purpose of the Study

There has been no research to show that TGT is superior to other teaching methods for teaching science on the high school level. Thus the first purpose of this study was to compare, in a seven-week field testing environment, the effects that teams-games-tournaments and traditional classroom methods had on the biology achievement scores of general-ability tenth grade high school students. The second prupose was to compare, following a delayed interval of ten weeks, the effects of TGT and traditional classroom methods on the cognitive retention of knowledge by biology students. A third purpose was to compare the effects of TGT and traditional classroom methods on student attitudes towards biology. A fourth purpose was to determine what attitudes students in experimental classes had of teams-games-tournaments as a pedagogical method for learning.

Answers to the following questions were sought in this investigation:

1. Would high school students playing teams-games-tournaments have greater academic achievement in a high school biology course than students in classes using traditional classroom methods?
2. Would high school students in TGT classes have a greater retention of knowledge after a delayed period of time than those students in classes using traditional classroom methods?

3. Would high school students in TGT classes have more positive attitudes toward the subject of biology than those students in classes using traditional methods?
4. Would high school students like TGT better as a means for studying chapter material than traditional classroom methods to which they had previously been exposed?

Definition of Terms

The following terms are defined as they apply to this study:

1. Educational Games. Games which are useful in attaining educational objectives or goals (Stadsklev, 1969, p.14).

2. Game. "Any contest (play) among adversaries (players) operating under contraints (rules) for an objective (winning)" (Stadsklev, 1969, p. 7).

3. Green-Version BSCS Biology. A biology curriculum developed by the Biological Sciences Curriculum Study Committee under the auspices of the National Science Foundation during the 1960's. The green version text has an ecological theme and has been designed to promote inquiry and scientific thinking about problems.

4. Instructional Games. Games which help participants obtain information or knowledge (Stadsklev, 1969, p.14).

5. Reward Structure. The means that teachers use to motivate students to perform school tasks (DeVries, 1976, p. 2).

6. Task Structure. The instructional activities created by the teacher (DeVries, 1976, p. 2).

7. Traditional Methods. Students are given reading assignments in the text. The teacher then presents most of this same assignment material in class-lecturing, interjecting questions, and discussing the information (Stadsklev, 1969, p. 8).

8. Team-games. Games in which players compete against each other for a goal in groups of four to five members with each member contributing to the collective good (winning) of the group (DeVries and Slavin, 1978, p. 29).

CHAPTER 2

REVIEW OF LITERATURE

Important investigations from 1949-1971 that led to the development of TGT involved the findings of researchers such as Morton Deutsch, James Coleman, Urie Bronfenbrenner, Layman Allen, David DeVries and Robert Hamblin.

In 1949, Morton Deutsch published his experimental results from a study of industrial psychology classes which were given hypothetical human relations problems to discuss and solve either in a competitive or cooperative situation. In some classes, each student was ranked with 4 other classmates for his contribution to the discussion, and his semester grade was based upon the average of his rank from 1-5. This structure was the competitive situation. Five other classes were told that they were going to be compared to each other and ranked 1-5 on the basis of how well they discussed and solved the human relations problems. Class members were induced to work cooperatively to insure the success of the entire class.

Deutsch found that in the competitive situation class members tried to impede one another in the discussion, solutions to problems were not as good as those in the cooperative situation, and there was much competition between individuals. In the cooperative situation, there was support by the group of each person's efforts, solutions to problems

were better among the classes, there was more cohesion among class members, and feelings of the students toward each other were much more positive than in the competitive situation. Thus Deutsch's experiment showed that it was possible for the group to work cooperatively and gain better formal rewards.

In 1959, James Coleman at Johns Hopkins University studied the values, interest, leisure time activities, and attitudes of 8,300 high school students in the Midwest. He found the competition, reward, and task structures of athletics to be effective in capturing the attention and energy of high school students. He suggested it was time to put competition and group cooperation to work for academics as well. He proposed establishing small work groups which could compete with each other on an academic basis.

> ...if there were systematically organized competitions, tournaments and meets in all activities ranging from mathematics and English through home economics and industrial arts to basketball and football, and if promotional skills were used, the resulting public interest and student interest in the activities would undoubtedly increase sharply. I suspect that the impact upon student motivation would be remarkably great - an impact due to the fact that the informal social rewards from community and fellow students would reinforce rather than conflict with achievement.
>
> ... motivation may be sharply altered by altering the structure of rewards to reinforce the aims of education rather than to impede them. (Coleman, 1959, p. 340)

Coleman said the "goal" of the student may often be learning to play the game for the purpose of winning, and thus he assimilates the material in order to gain his goal. The goal of getting good grades may also be attached to the goal of winning. Thus these goals imply

> appropriate games for learning are those in which winning, or attainment of the goal, is in fact facilitated by the knowledge that the school is attempting to "teach." (Coleman, 1968, p. 66)

Urie Bronfenbrenner, in his book Two Worlds of Childhood, published in 1970, reported on his studies of the American classroom and how children are brought up in the United States. He said that processes such as group commitment and involvement in goals can be encouraged within the classroom by teams, cooperative group competition and mutual help. He saw the differences in race, background, and origin as having a negative effect on cooperation and keeping Americans apart. He visited the Soviet Union seven times from 1960 - 1967 and compared the schools and methods of childrearing in the United States and the Soviet Union. He found that students in Soviet Schools were more often involved in cooperative community projects.

> But, surely, the most needed innovation in the American classroom is the involvement of pupils in responsible tasks on behalf of others within the classroom, the school, the neighborhood, and the community. (Bronfenbrenner, 1970, p. 156)

David L. DeVries, Keith Edwards, and others at Johns Hopkins were influenced by the writings of these three men. They were also impressed by a study published by Layman Allen and his associates of the University of Michigan in 1969 of a non-simulation math game called "Equations." This game required students to construct algebraic expressions equal to a specific number using a given set of digits and symbols. Students competed at tables to which they had been initially

assigned on the basis of ability. At the end of the competition, students would be "bumped" to higher or lower tables, depending on their success or failure in playing the game. Students belonged to teams yet competed individually at tables. Allen published newsletters which kept the students abreast of their team scores and team rankings. Allen published results in 1970 from his 1964 studies of non-simulation math games conducted in a suburban California high school, which showed significant increases in scores on the Stanford Achievement Test of math for experimental groups as compared to control groups. DeVries and Edwards were so impressed by Allen's game that one of the first TGT studies ever conducted in 1972 used the game "Equations."

Prior to using "Equations" and the Allen methods, David DeVries, Donald Muse and Elizabeth Wells conducted an exploratory study of the effects of students working in cooperative groups. The study was conducted in six American history classes at suburban Melbourne High School, Melbourne, Florida, for a period of one year. Three of the intact classes taught by one teacher were set up with cooperative groups, each of which had a leader who chose members of his group. An individual's grade was based on his work in the group and his performance on tests. Three control classes taught by another teacher were conducted in the traditional pattern of competition for grades on an individual basis. DeVries and his associates collected data via questionnaires and interviews only during the last week of classes at the end of the year. This study had several weaknesses, such as (1)

the way in which group membership was determined, (2) data collection occurring only at the end of the year with no earlier observations, (3) students feeling they were only peripherally involved in group action, and (4) a post-test only design with no pre-testing of experimental and control groups. Students from cooperative classes did feel they experienced more peer pressure for involvement, assigned greater importance to their classmate's expectations, and interacted more frequently with each other. This 1971 study pointed out the need for a better method of group selection and Allen's methods were seen to have a better design so that "no individuals could 'drag their feet' and let the rest of the group do the work" (DeVries, August, 1976, p. 6).

In 1971 Robert Hamblin, a behavioral sociologist, conducted a study of cooperative groups and the effect of team scoring systems on academic achievement. His groups were comprised of individuals who were high, middle and low achievers. He found there was greater academic achievement of the entire group when peer-tutoring of low achievers by high achievers took place (Hamblin, 1971).

Creation and Research of the TGT Method

David DeVries and Keith Edwards combined the ideas of Allen and Hamblin into their own teams-games-tournaments structure. Using this structure, they conducted their first TGT study in 1972 with 96 seventh-grade math students for nine weeks with the team game "Equations." The study showed positive effects for TGT on achievement measured by the math section of the Stanford Achievement

Test and a curriculum specific test designed by the researchers, although no reliability or validity data were reported for the curriculum specific test (Edwards and DeVries, 1972, p.6). Success was attributed to peer tutoring and the cooperative team, the game, and the "bumping" procedure which motivated students to achieve. The unique game of "Equations" by itself may have been a primary factor in affecting achievement.

Edwards and DeVries repeated the study again in 1972 with 110 seventh-grade math students for four weeks, again using the game "Equations." They attempted to find out if it was the teams or the games that were having the positive effects on achievement. They found it was the games aspect that produced the largest effects on achievement. Four attitude tests were given, and again it was the games aspect that influenced attitudes most. The major reason given by students as to why they liked the games was the social interaction that they had with other students. Treatment groups were told that team scores would affect their grades.

In the third study, DeVries and Edwards modified the TGT groups in seventh-grade math and social studies classes. The scoring system of one treatment TGT group was changed to give greater point advantage to high achievers. In previous studies high achievers as a group had reported not liking TGT. Another treatment group which engaged in TGT, but did not compete against other teams in the class, was used to study the element of team competition. A TGT group and a control group were part of the twelve-week study. In all TGT

groups, students were told their course grade would be affected by team performance. All TGT groups were found to do better than control groups on curriculum specific math achievement tests. Again, this was using the researcher-made test for which the investigators had stated there was no reliability or validity data. When competition between teams was eliminated, results suggested that there was a loss of team cohesiveness. A social studies game called "Ameri-card" had no significant effects on achievement. Again, the game "Equations" may have been the element that was so important in math and not the TGT technique.

To find out if results were due mainly to "Equations," a study (Hulten and DeVries, 1976) was conducted for ten weeks in ten seventh-grade math classes using a different game called "TUF" (Avalon-Hill Company, Baltimore, Maryland). This study also assessed the importance of the team practice component of TGT. Students in control classes played games but represented only themselves in competition. Students in the TGT groups engaged in team tutoring, competed as representatives of a team, and were given team scores. Student attitude tests toward game success and games were administered. An Arithmetic Computation subtest of the Stanford Achievement Test showed significant results for the effects of TGT on achievement scores, particularly for low achievers. TGT also affected student attitudes positively towards their academic tasks, probability of success, and classmates. This study demonstrated that TGT did work with a math game other than "Equations."

The effects of TGT in a different subject area and on a different level were tested (DeVries, Edwards, and Wells, 1974). TGT was used in social studies classes for twelve weeks at the high school level. Team-scoring was changed to give more point weight advantage to low achievers. Students involved with TGT were told their team scores would affect their course grade. A test of attitudes towards American history and the Learning Environment Inventory Test of Walberg and Anderson were given to assess classroom satisfaction and apathy. SCAT-STEP social studies subtests showed no differences between experimental and control classes in academic achievement. Curriculum specific tests showed TGT students gained more than control ($p < .10$) (DeVries, 1978, p. 1). TGT had positive effects on student attitudes towards history and created greater satisfaction and less apathy.

The effects of TGT then were investigated in the field of language arts at the elementary level (DeVries and Mescon, 1975). Only two third-grade classes were used for six weeks in the study. The Hoyum-Sanders Elementary English Test and a treatment specific test were administered before and after treatment to measure achievement differences between experimental and control classes. Attitude tests for student perceptions of the class were given. Although results from the standardized Hoyum-Sanders test were mixed, the TGT class did better than the control class on parts of it. For the curriculum-specific test, the TGT class did better on some parts than the control class. There was no significant difference in attitudes between groups. The mixed results on achievement were explained by the statement that

"standardized tests of achievement are often insensitive to classroom interventions that are designed to increase specific skills" (DeVries and Mescon, 1975, p. 16).

This study at the elementary level was repeated again for six weeks using two third-grade classes (DeVries, Mescon, and Shackman, 1975a). However, two differences in design are noted. At the end of the experiment, "play-offs" were conducted between the first place teams and a class champion was declared. Secondly, new tests were made to measure the targeted skill areas. The new test consisted of items from the Hoyum-Sanders for the treatment-specific test. According to the report, there were greater pre-post test gains by the TGT students than by the control group students on both standardized and treatment specific tests. "Play-offs" may have fired enthusiasm in the TGT classes and contributed to the results.

Another study was conducted for five weeks using two third-grade classes that were studying vocabulary and verbal analogies (DeVries, Mescon, and Shackman, 1975b). Achievement was the only factor measured. Two researcher prepared measures of vocabulary skills and two measures of skills in verbal analogies were administered. TGT students were found to have made higher gains in achievement. Low achievers made bigger gains than average or high achievers.

Language arts had not been studied on any level other than elementary; therefore, an investigation was conducted for ten weeks in junior high language arts (DeVries, Lucasse, and Shackman, 1980). In addition to studying the effects of TGT on the cognitive achievement of

experimental and control groups, the study also investigated the effects on achievement of TGT workshops for teachers participating in the study. TGT was found to increase scores on curriculum specific tests. But this result did not hold true for standardized measures. Teacher training had no significant effect on student achievement.

The tenth and last study was conducted for ten weeks by Robert Slavin in four junior high social studies classes of emotionally disturbed adolescents. TGT was found to have no significant effect on achievement using standardized or curriculum specific tests. Students in TGT classes did show more mutual concern towards each other and developed a greater number of friendships.

Eight of the ten studies investigated effects of teams-games-tournaments on attitudes toward school using the Learning Environment Inventory developed by Walberg. Three of the studies showed positive effects on attitudes (Edwards and DeVries, 1971; Edwards and DeVries, 1974; DeVries, Edwards and Wells, 1974), but five others did not (Hulten and DeVries, 1976; DeVries and Mescon, 1975; Devries, Mescon, and Shackman, 1975a, DeVries, Lucasse and Shackman, 1979; Slavin, 1977).

Because a large body of research had indicated that cooperation had a positive effect on mutual liking (Lott and Lott, 1965), seven studies investigated through questionnaires and sociometric measures the mutual concern among members of teams. Five of these studies showed TGT to increase mutual concern among students. The two studies where this effect was not found were those in which students

had shown strong mutual concern on pretests. The five studies favorable to TGT for mutual concern were Edwards and DeVries, 1972; Edwards and DeVries, 1974; DeVries, Edwards, and Wells, 1974; DeVries, Lucasse and Shackman, 1979; and Slavin, 1977.

Five studies investigated the effects of TGT on peer opinions concerning academic performance to see if students would place more value on performance in the classroom. Questionnaires were used in these investigations. Positive TGT effects were found in four of these studies (Edwards andDeVries, 1974; Hulten and DeVries, 1976; DeVries, Edwards, and Wells, 1974; Slavin, 1977).

All of the studies were conducted in ongoing public school classes by teachers normally assigned to those classes. In all of the studies the academic achievement of the experimental and control groups was measured for differences. In all of the studies, TGT, a cooperative learning method, was pitted against traditional competitive classroom methods.

Since 1977, TGT has been compared with other cooperative learning methods such as "STAD" and "Jigsaw." Both "STAD" and "Jigsaw" utilize teams, team practice, worksheets, and a newsletter just as TGT does, but "STAD" replaces TGT games with quizzes and bonus points to students who perform higher than expected. "Jigsaw" is designed to make each student become an expert on one part of an instructional unit and then teach that part to others on his team. Quizzes are given to check progress of the teams and bonus points given to high performing students. TGT is the most widely researched

of the three. "The TGT studies have the largest number of positive effects on achievement of all the cooperative techniques" (Slavin, 1980, p. 334). Yet Slavin goes on to say that "more rigorous studies might be less likely to find significantly positive effects than less rigorous ones. Experimental rigor does explain some of the differences between studies (and between techniques)" (Slavin, 1980, p. 334). This statement by Slavin implies that many of the research studies of TGT may not have shown significant results in favor of TGT had there been more experimental rigor and control imposed.

Research on TGT is continuing. Over 200 TGT math games have been developed at the Center for Creative Leadership in Greensboro, North Carolina. Johns Hopkins University has also developed a complete set of TGT games for junior high science through funding from the National Science Foundation. During 1982 and 1983 Marshall Leavey of Johns Hopkins studied the effectiveness of TGT in junior high life science classes.

Theoretical Models Associated with TGT

The motivational models of John Atkinson of the University of Michigan and N. T. Feather are used to explain why team games are thought to cause advances in achievement. According to Feather, motivation is a function of two variables: (1) perceived probability or expectancy of success, P_s, and, (2) the incentive value or importance of that success (Feather, 1966, p. 64). Atkinson had postulated that motivation is highest at intermediate levels and stated that "the

strength of motivation . . . decreases as P_s increases from .50 to near certainty of success (P_s = .90) and it also decreases as P_s decreases from .50 to near certainty of failure (P_s = .10)" (Atkinson, 1966, p. 17).

Drawing on the theory of Atkinson, DeVries devised the structure of TGT to allow low achievers to compete only against low achievers, while high achievers must outperform other high achievers to win. Thus all students in a class have an equal probability of success in the intermediate range of difficulty rather than the extreme of being too easy or too hard (Hulten and DeVries, 1976, p. 7). There is greater expectancy of success because motivation is maintained with both low and high achievers.

The team component of TGT is presumed to increase the incentive value or importance which pupils attach to success in two ways:

> (1) interdependence (is) ...thought to foster identification with the team, and the development ... of group goals, one of which is winning at the instructional game, and
>
> (2) identification with a team (is) presumed to lead to ... a climate such that success ... is rewarded by classmates rather than ignored or discouraged. Thus students enjoy the game ... more when they play as representatives of a team than when they represent only themselves. (Hulten and DeVries, 1976, p. 7)

In the teams-games-tournament situation, according to DeVries, the task structure of the class is changed from that of the traditional individual task to a group task and the individual competitive reward structure is also changed to that of a cooperative reward structure.

He defined a group task as one in which students help each other in a learning activity and a cooperative reward structure as one in which rewards are given to a group based on the performance of that group. DeVries (1976, p. 3) stated that the traditional individual task and reward structure pits one student against another and disrupts interpersonal bonds among students. As a result students have tended to discourage academic performance among their peers. DeVries cautioned that a cooperative reward structure must be carefully set up if it is to help academic performance. Essentials for success with TGT are that the classroom situation be designed so that no individual can refrain from participating in the group, that the group be rewarded at the group level, and that rewards be frequently made (DeVries, 1976, pp. 6-7). Even then, factors such as team size, task structure, reward, and methods of assigning students to teams may affect success.

Summary

Teams-games-tournaments has had its greatest effects on curriculum specific achievement scores in math and language arts at the elementary and junior high level. There has been no research reported of its academic effectiveness in science courses. Since only one study (DeVries, Edwards, and Wells, 1974) was undertaken on the high school level and showed a "marginal" significant difference in achievement scores for the experimental group, a need was seen for more research of TGT on the high school level.

The studies examined in this chapter reveal a number of other areas of concern. Teachers in experimental and control groups were not always required to have the same lesson plans and instructional schedule. Not all studies reported that experimental and control groups used the same worksheets. No attempt was made in any of the studies to measure delayed retention of knowledge. Some curriculum specific tests had no reliability or validity data available. In some studies students only performed significantly better on two or three parts of the overall achievement test. TGT did not fare as well for increasing achievement when standardized tests were used. In some studies, students in TGT classes were told that their grade would be affected by their team's performance. The effects of TGT on student attitudes toward school were positive in only three out of eight studies.

In summary, research has shown that TGT is effective for courses which have easily quantifiable behavioral objectives or concrete skill areas (DeVries, 1976, p. 72) at the elementary and junior high levels. No research was reported that demonstrated that TGT can be used as a successful motivational technique for learning at the high school level and that it can make a difference in attitudes and achievement. DeVries states, "To extend the assessment of effectiveness of TGT as an instructional technique, the technique needs to be used in different subject areas, with students of different age levels" (DeVries, 1974, p. 2). This study was designed to provide information about the viability of the TGT method for use in high school biology classes.

CHAPTER 3

METHODOLOGY

This study involved eight high school biology classes which were grouped into four control and four experimental groups. The experimental classes then underwent the treatment technique of TGT for seven weeks. This chapter describes the subjects, the TGT method and procedures, the scoring, the instruments used, and treatment of the data.

Description of Subjects

The study encompassed tenth-grade students in eight intact BSCS Green Version Biology classes at Cave Spring High School in Roanoke, Virginia. These students were grouped as general-ability students in this suburban high school which serves a community in which many professional people live. Approximately 70 percent of the students go on to college.

At the beginning of the study the sample consisted of 241 students. The post-tests were administered to 193 students at the conclusion of the experimental treatment period. The attrition rate was attributed to extended illness, accidental personal injury, transfer to other biology classes, or permanent withdrawal from school.

Basic Description of the TGT Method

The teams-games-tournaments method (TGT) had three components: team competition, instructional games, and tournaments. Students in a class were assigned to three, four, or five member teams, depending on class size, with each team reflecting a cross section of the class as to academic ability, race, and sex. Once a team membership was formed, it remained constant and students in each team competed against members of other teams in academic games covering course material. Team members tutored each other to get ready for tournaments in a 20-40 minute team practice (DeVries, 1974a, p. 6) held earlier in the week before the tournament. Tournaments in which the teams competed against each other were held once a week for 30-45 minutes. Newsletters were distributed each week to the teams which announced winners and team standings.

Each team consisted of two high-ability students, two average-ability students, and one low-ability student, or one high-ability student, two average-ability students, and one low-ability student. When a tournament was played, tables were set up in two divisions or leagues. If each team consisted of four members, there would be four tournament tables in each division. For the first tournament played, this researcher assigned students to each table based on previous grades and ability scores. Table 1 had the high-ability student from each team and these four students competed against each other. Table 2 had four average-ability students, as did Table 3. Table 4 had four low-ability students. After this first

tournament, students switched tables depending on their performance. For the next tournament, the person with the highest number of points at each table was "bumped" to the next higher table (with Table 1 being considered the highest). The person with the second and third highest number of points stayed at the same table. The person with the lowest number of points was "bumped down."

The game involved the use of simple course content questions for students to answer. The questions included material already covered in class, reading assignments, or team practice. There were numbered questions on a ditto sheet at each table. The student drew a number from a card pile and then answered that particular numbered question from the ditto sheet. If other members did not think the student answered the question correctly, they challenged the answer. The students then checked an answer sheet provided by the teacher for the correct answer.

The points for each team were tallied from its members' scores, and each question answered correctly was worth a point. A high achiever could have earned six points, the two average achievers could each have earned six points, and the low achiever could have earned six points to give a grand total to the team of twenty-four points. Each team also had a team standing in relation to all the other teams. Class newsletters announced individual top scores, the team with the most points, and team standings.

Procedure

The five classes of Teacher A and five classes of Teacher B were given a 50-item multiple choice pre-test consisting of questions drawn from the BSCS test booklet for the chapters used in the study. Classes of each teacher were ranked by the means from this test and a random procedure was used to assign one of the top two scoring classes and one of the bottom two scoring classes to the experimental treatment. The eight classes which participated in the study were taught by two teachers, each teaching two TGT classes and two control classes. Teacher A and B each had a control class in the morning and one in the afternoon, and each had an experimental class in the morning and one in the afternoon.

The experimental treatment period lasted seven weeks, which is within the six to ten week period recommended by Slavin (1978, p. 20). Both experimental and control groups studied chapters 12, 13, and 14 on cell biochemistry, plant physiology, and the functioning animal from the BSCS text. Both teachers were instructed to assign students in both the experimental and control classes the same regular textbook readings. All classes were engaged in identical preparations for labs, use of audiovisual materials, discussions, lectures, and completion of worksheets. The major differences between the experimental and control classes were that once a week a team practice session was held for 25-35 minutes in experimental classes, and once a week a teams-games-tournament was used in the experimental classes for a class period, whereas traditional discussion, question-answer methods, and

quizzes were used in control classes as suggested by Edwards and DeVries (1972). Worksheets for each chapter were given to all students in both experimental and control groups. These same worksheets were then used in the playing of the teams-games-tournaments.

Team Assignment

Students were assigned to three, four or five member teams. A four-member team consisted of one high-ability student, two average-ability students, and one low-ability student. Information as to ability was obtained by the investigator from the student files. For each experimental class, students were ranked first according to their first semester biology grades from highest to lowest. If two or more students had the same average, then their Differential Aptitude scores or Standard Test of Educational Ability was used as another delineating factor for putting them in a rank order. The ninth-grade grade averages were compared as an additional factor. Most classes had eight teams. For example, if there were 32 students in the class, there were eight teams with four members each. If division was uneven, there could be one, two, or three teams composed of five members. Once a list of students ranked by achievement had been made, team letters were given to each student. If there were eight teams, then eight letters were used. Table 3 illustrates how students in one 25-member class were assigned to teams according to the TGT methods.

Table 3

Team Assignments for a Class

Teacher A - 4th Period - 25 People - 5 teams w/4, 1 team w/5

	Student	Semester BIOLOGY Grade	Higher DA or STEA	9th Grade Grade Average
High				
A	1	97	99	A
B	2	92	98	A
C	3	91	99	B
D	4	90	85	B-
E	5	90	80	A
F	6	88	85	B-
Middle				
F	7	86	90	C
E	8	86	60	C
D	9	85	79	A
C	10	84	75	D
B	11	83	79	C
A	12	82	64	C
	13	81	70	C
A	14	80	85	C
B	15	80	72	C
C	16	80	49	D
D	17	80	36	C-
E	18	77	68	C
F	19	77	55	C
Low				
F	20	76	50	D
E	21	76	43	D
D	22	75	70	D
C	23	75	45	D+
B	24	75	36	D
A	25	68	90	D+

All A's were then grouped as a team, all B's as a team, all C's, etc. Student 13 was added to a team as a fifth member. Teams were checked for race and sex balance. (Minor variations can be made in assignments, according to TGT, if there are poor combinations or maturity problems with teammates.) Once students were assigned to teams, their names were then written on team summary sheets (see Appendix H).

A practice session using TGT and explaining its rules was held in experimental classes a week before the study began. At that time students were informed that they were going to be using a new way of learning called TGT; they were given their team assignment and were asked to think of a name for their team. They then competed in a TGT setting using worksheets and material from a chapter they had studied earlier.

Once the study began, each student in the experimental classes completed his worksheets, read the chapter, and prepared for the team game. Once a week in experimental classes, a 25-35 minute team practice session was held. Students moved their desks together, tutored each other, and checked with each other to make sure everyone had completed the worksheet. The teacher provided a correct answer sheet so students could check their answers. On the days that team practice was held in experimental classes, control classes worked on the worksheet. The next day the teacher would go over the worksheet in

control classes, conduct a question-answer session, and then give a quiz.

Tournament Play

When tournaments were played, tables were set up in two divisions or leagues with three or four tournament tables in each division. For example, in a 32-member class each team consisted of four members, so there were four tournament tables in each division. For the first tournament the students were assigned to a table for playing the games. Tournament Table 1 in each league consisted of the high-ability students from each team and these four students competed against each other. Tournament Table 2 in each league had four average-ability students, as did Table 3. Table 4 in each league had four low-ability students. This arrangement is illustrated on the next page in Figure 1.

During the game, there was a worksheet of numbered questions at each tournament table. There was also an answer sheet lying face down, a set of numbered cards, and a game score sheet on which students wrote their names and final number of points at the end of the game. To decide who received the first question, the numbered cards were shuffled. Each student drew a number and the student holding the highest number at each table began the game. The numbered cards were reshuffled and placed face down. The first student drew the top number card, read aloud the question from the ditto sheet that corresponded to the number, and gave an answer. If other members at the table did not think the answer was correct, they challenged the

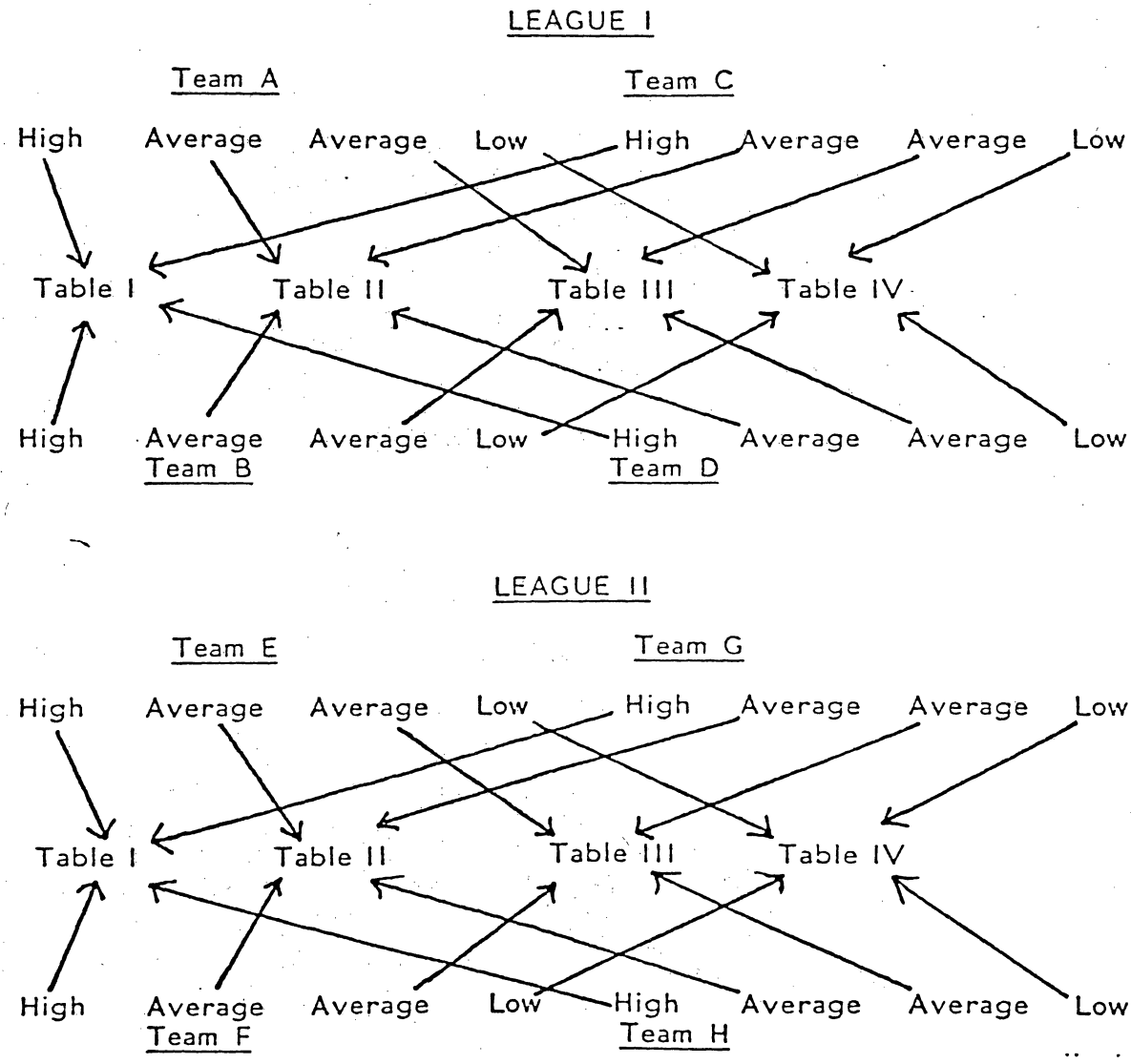


Figure 1

Assignment of Students to Tables and Leagues

answer and gave different responses, and the answer sheet was checked for the correct answer. If the student who originally drew the card was correct, he or she kept the numbered card as if it were a point. Challengers who gave wrong answers lost a point or card. If the challenger was right, he or she retained the card. If no one was right, the card went to the bottom of the deck. If the reader was wrong, nothing happened, but if the challenger was wrong, he or she put a card back in the deck.

For the next round of the game, the next person to the left drew a card off the deck, read the question corresponding to the number aloud and gave an answer, waited for challengers to give an answer, and checked the answer sheet. Play continued until the period ended or the deck was exhausted. When the game was over, each player counted the number of cards he or she was holding and put the number won on the game score sheet. Each game had no more than thirty questions, and if there was time, the players reshuffled the cards and played the game a second time. All tables had the same question sheet for playing the game.

Five minutes before the end of the period students were told to stop, count their cards, and fill in the game score sheet, as illustrated.

Player	Team	Game 1	Game 2	Game 3	Day's Total	Tourn. Points
Jerry D.	Geniuses	5	7		12	
Nancy P.	Eagles	14	6		20	
Cordell P.	Giants	5	5		10	
Tyler M.	Bears	6	12		18	

Scoring

The game score sheets were taken up and given to this investigator who then calculated the tournament points. In a four player game with no ties, the top scorer received six points, the high middle scorer received four points, the low middle scorer received three points, and the low scorer received two points. If there were ties or fewer than four players competed, this investigator then consulted the appropriate tables devised for the TGT method (see Appendix L), assigned tournament points, and prepared a summary sheet for each team. This procedure involved transferring tournament points for each person to their team summary table as illustrated below in Table 4.

If a team had four members, their team score remained as it was. But if a team had five members or if someone was absent on a four-member team, scores were transformed using a prorating score sheet (see Appendix G) so that the total team score was comparable to the scores of four-person teams. Transformed scores were used to get cumulative scores.

Once all team scores had been calculated and recorded on their proper sheets, the scores for each team for the week were publicized in the class newsletter. The newsletter announced top scorers, the team with the most points, and the team standings (see sample newsletter in Appendix M). A bulletin board was also put up to publicize team standings and generate ethusiasm.

Table 4

Team Summary Table

TEAM NAME: GENIUSES

Team Members	Tournament No. 1	2	3	4	5	6	7	8	9	10
Jerry F.	6	2	2							
Linda P.	4	4	2							
Gary S.	5	2	4							
John	6	6	2							
Elsie	4	4	6							
Total Team Score	25	18	16							
Transformed Team Score	20	14	13							
Team Standing This Week	1	3	5							
Cumulative Score	20	34	47							
Cumulative Standing	1	1	2							

Reassignment Procedure

After each tournament, students were "bumped" or reassigned to new tables as seen in Appendix K. A tournament score sheet for each class was completed with the names of the students, their team name and the table to which they were assigned. The game score sheets were used to determine winners and losers at each table. Winners had a circle put around their table number, while students who were low scorers had their table number underlined. If there were ties for winners or losers, a coin was flipped to decide which to circle or underline. Competition was most difficult at Tournament Table 1 and least difficult at Table 4. If a table number was circled, it was reduced by one (4 became 3). That meant the student moved to Table 3 for the next week where competition was more difficult. Table numbers that were underlined were increased by one (3 became 4). Low scorers competed the next week at a Table where competition was less difficult. If a Table number was not circled or underlined, then the student remained at the same Table for the next tournament (see sample sheet in Appendix K).

Instruments Used

A 50-item multiple choice curriculum specific cognitive pre-test was given to all students involved in the study on December 9, 1981. The experimental treatment period began on February 4, 1982, and was concluded on March 23, 1982. At the end of this seven-week period, a

60-item curriculum specific post-test was given to all students on chapters 12, 13, and 14 to measure cognitive knowledge. This 60-item curriculum specific post-test was administered again after a delayed interval of ten weeks on May 31, 1982, to measure retention of knowledge. The pre-test and post-test for cognitive knowledge were developed using questions from the BSCS test booklet prepared by testing experts for the BSCS curriculum studies. The internal reliability estimate for the pre-test was .54 and the reliability for the chapters post-test was .72 as determined by use of the Kuder-Richardson (KR-20) formula. This same post-test used as the delayed retention test had a reliability of .65 when used in May.

An attitude test towards biology was administered to all students on December 9, 1981, prior to the beginning of the study, and again on March 23, 1982, at the conclusion of the treatment period. This attitude test was created by James Russell and Steve Hollander of Purdue University to measure attitudes of students towards biology and was found by them to have a reliability of .90. The test consisted of 14 Likert scale questions and was used intact as published. The Russell and Hollander test was used as a model to develop a questionnaire consisting of 14 Likert scale questions on attitudes towards team-games by inserting the word "team-games" in place of the word "biology". The game-attitude test was only administered to those students in experimental classes, and was given the second week and the seventh week during treatment. It was not appropriate to ask the

pupils in the control group to express attitudes toward games since they did not participate in their use.

The 50-item multiple choice pre-test, the 60-item multiple choice post-test, the biology attitude questionnaire, and the team-games attitude questionnaire can be found in the appendices of this paper. Figure 2 illustrates when tests were administered during the study.

Collection and Treatment of the Data

The independent variable of experimental interest was the use of traditional review versus TGT as used in the experimental classes. The dependent variables were the achievement scores after the method of TGT was used, attitude scores towards biology after treatment with TGT, attitude scores toward team-games after treatment with TGT, and cognitive retention of knowledge scores.

In order to insure comparability of groups of pupils assigned to these two conditions, each teacher had two control classes and two experimental classes. Both teachers were female. To control for the time variable each teacher had a control class in the morning and one in the afternoon. Likewise each teacher had an experimental class in the morning and one in the afternoon.

For the purposes of compiling the data for the study, students recorded their answers for all tests on optical scanning sheets and identified their sheets with pre-assigned identification numbers. These numbers identified their teacher, class period, name, and type of class

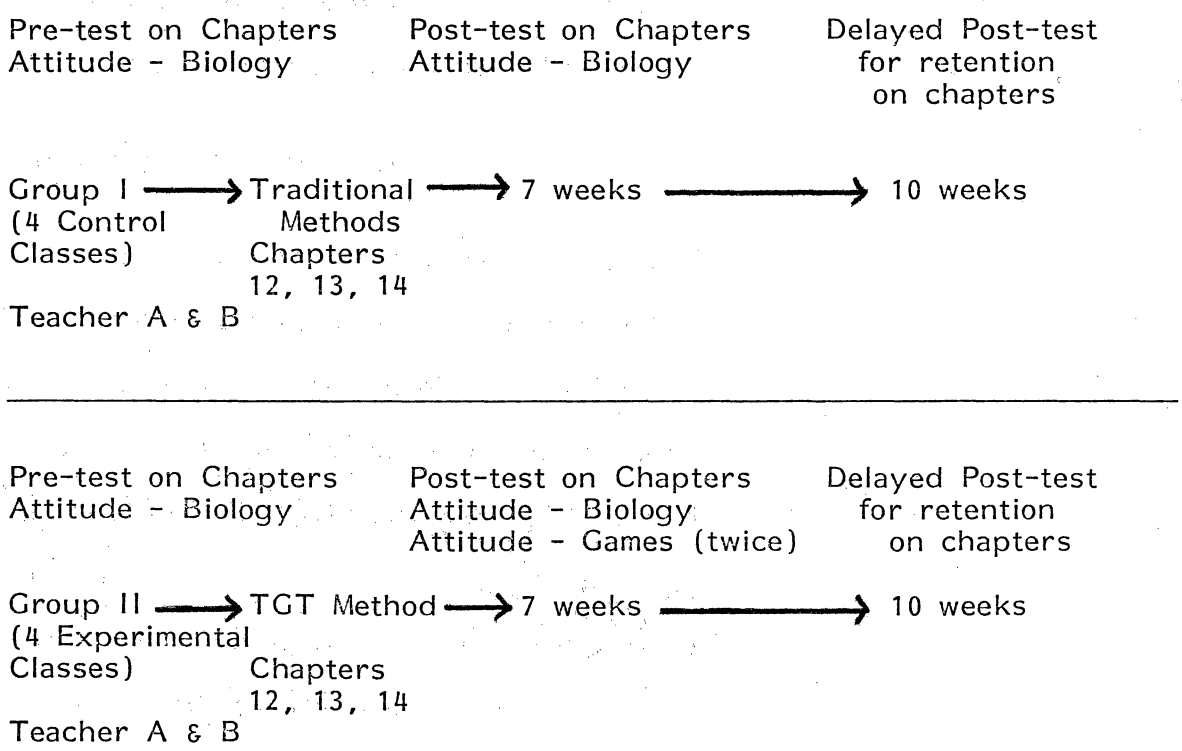


Figure 2

Time Schedule for Administration
of Tests

(control or experimental). The student responses were then transferred to computer cards for analysis.

Since intact classes were used in this study and randomization of students in classes was not possible, pre-tests were given to see if the groups were equivalent in their attitudes toward biology and cognitive knowledge of the subject. The cognitive pre-test was given and the means determined for ten biology classes. Those classes of each teacher having similar means were then matched and a random procedure used to determine which classes were to be control and which experimental. An analysis of variance was computed to determine whether there was a significant difference between control and experimental groups on the cognitive pre-test using the Statistical Package for the Social Sciences (Nie, Hull, Jenkins, 1975) computer package. The alpha level or level of significance used was .05.

Analysis of variance was computed between experimental and control groups for

(1) the pre-test cognitive knowledge means,

(2) the post-test means for Chapter 12, 13, and 14,

(3) the delayed post-test means,

(4) the biology attitude pre-test means,

(5) the biology attitude means following the 7-week treatment.

For all of these analyses the level of significance was .05 and the Statistical Package for the Social Sciences ANOVA procedure was utilized.

In order to control for differences in I.Q. and for pre-treatment cognitive knowledge, the I.Q. scores and the pre-test scores of each student were used as covariates in analysis of the data resulting from the seven-week treatment period. The analysis of covariance was also used with data from the delayed post-test.

Response frequencies for attitudes toward team-games were obtained for those classes involved in the treatment. This attitude test was given the second and seventh week of treatment. A dependent t-test was then computed to determine whether there was a significant difference in the attitude means of the experimental group between the second and seventh week of the study.

CHAPTER 4

RESULTS OF THE STUDY

Analysis of variance was used to test mean differences between experimental and control groups on the cognitive pre-test, post-test, and delayed post-test, and on the biology attitude pre-test and post-test. A summary of all means compared between experimental and control groups for all biology achievement tests and all attitude tests during the study is given in Table 5. Analysis of covariance used the I.Q. scores and the pre-test scores of each student as covariates with scores of the cognitive post-test and delayed post-test. A dependent t-test was computed for the experimental group's attitudes toward team games between the second and the seventh week.

Cognitive Achievement Data

The 50-item pre-test measure was given before the treatment began in order to determine if experimental and control groups were roughly equivalent in cognitive knowledge. The means from the experimental and control groups on this pre-test was tested for significance through the use of analysis of variance. The mean for the experimental group was 20.36 and the mean for the control group was 19.48. As shown in Table 6, there was no significant difference between control and experimental groups on the pre-test measure of cognitive knowledge.

TABLE 5

Summary of Means for All Tests

GROUP MEANS FOR BIOLOGY ACHIEVEMENT TESTS

	Pre-test SD	Post-test SD	Delayed Post-Test SD
Experimental	20.36 (4.78)	35.41 (6.22)	34.56 (5.16)
Control	19.48 (4.53)	34.25 (6.40)	33.54 (5.70)

GROUP MEANS FOR BIOLOGY ATTITUDE TEST

	Pre-test SD	Post-test SD	Change
Experimental	2.70 (0.58)	2.79 (0.62)	+.09
Control	2.81 (0.63)	2.77 (0.64)	-.04

EXPERIMENTAL GROUP MEANS FOR GAMES ATTITUDE TEST

Week 2	2.24	(SD = 0.60)
Week 7	2.22	(SD = 0.77)

Table 6

Pre-Test of Cognitive Knowledge:
Analysis of Variance

SOURCE	DF	SS	MS	F	P
Between Groups	1	38.29	38.29	1.77	0.19
Within Groups	196	4241.64	21.64		
TOTAL	197	4279.93			

Mean for Experimental Group: 20.36
Mean for Control Group: 19.48

Having determined that the groups did not differ on the pre-test, attention was then focused on the post-test results. The first research question was stated as:

1. Would high school students playing teams-games-tournaments have greater academic achievement in a high school biology course than students in classes using traditional classroom methods?

The 60-item post-test was analyzed first by using analysis of variance. Table 7 shows the summary ANOVA table. There was no significant difference between the experimental group mean of 35.41 and the control group mean of 34.25 on the post-test. In order to increase statistical power, the analysis of covariance was used in which I.Q. scores and pre-test scores were used as covariates. Even after controlling for these factors, the groups did not differ significantly as shown in Table 8.

The second question of the study was

2. Would high school students in TGT classes have a greater retention of knowledge after a delayed period of time than those students in classes using traditional classroom methods?

The delayed post-test scores were analyzed first using analysis of variance. Table 9 gives the results of this computation. The means of 34.56 for experimental and 33.54 for control were not significantly different. Again, analysis of covariance was computed using I.Q. scores and pre-test scores as covariates. The analysis of covariance again showed no significant difference between experimental and control groups as shown in Table 10.

Table 7

Chapters Post-Test of Cognitive Knowledge:
Analysis of Variance

Source	DF	SS	MS	F	P
Between Groups	1	65.95	65.96	1.66	0.20
Within Groups	192	7651.15	39.85		
TOTAL	193	7717.11			

Mean for Experimental Group: 35.41
Mean for Control Group: 34.25

Table 8

Chapters Post-Test: Analysis of Covariance

Source	DF	SS	MS	F	P
Covariates	2	1839.03	919.51	31.30	≤0.01
Main Effects	1	6.21	6.21	0.21	≤0.67
Explained	3	1845.24	615.08	20.93	≤0.01
Residual(Error)	189	5553.25	29.38		
Total	192	7398.49	38.53		

GRAND MEAN = 34.89

	UNADJUSTED MEAN	MEAN ADJUSTED FOR COVARIATES
EXPERIMENTAL	35.41	35.08
CONTROL	34.41	34.72

Table 9

Delayed Post-Test: Analysis of Variance

Source	DF	SS	MS	F	P
Between Groups	1	50.03	50.03	1.69	0.20
Within Groups	191	5661.74	29.64		
TOTAL	192	5711.77			

Mean for Experimental Group: 34.56
Mean for Control Group: 33.54

Table 10

Delayed Post-Test: Analysis of Covariance

Source	DF	SS	MS	F	P
Covariates	2	1540.09	770.04	34.77	≤0.01
Main Effects	1	11.22	11.22	0.51	≤0.48
Explained	3	1551.31	517.10	23.35	≤0.01
Residual(Error)	187	4141.83	22.15		
TOTAL	190	5693.14	29.96		

GRAND MEAN = 34.06

	UNADJUSTED MEAN	MEAN ADUSTED FOR COVARIATES
EXPERIMENTAL	34.63	34.32
CONTROL	33.54	33.83

The results of the above analyses give no evidence that the TGT treatment had any effect upon cognitive ability as measured by the post-test or the delayed post-test in this study.

Attitude Data

The third research question of the study was

3. Would high school students in TGT classes have more positive attitudes toward the subject of biology than those students in classes using traditional methods?

The biology attitude questionnaire was given before the treatment began in order to determine if experimental and control groups were roughly equivalent in attitudes towards biology. Statistical analysis of this pre-test data was computed through the use of analysis of variance. The mean for the experimental group was 2.7031 and the mean for control was 2.8070. The analysis of variance which is shown in Table 11 reveals no significant differences between the means of control and experimental groups on the pre-test measure of attitudes. (Negatively phrased statements were recoded prior to summing the responses in computing attitude scores for analysis - see Appendix D.)

At the end of the seven-week period of playing team games, the biology attitude questionnaire was readministered to both groups. The data was analyzed through use of analysis of variance and no significant difference between groups was revealed as shown in the summary of this anaylsis in Table 12. Not only did the groups not differ significantly when pre- and post-measures were compared

Table 11

Pre-Test of Attitudes Towards Biology:
Analysis of Variance

Source	DF	SS	MS	F	P
Between Groups	1	0.54	0.54	1.46	0.23
Within Groups	198	73.33	0.37		
TOTAL	199	73.87			

Mean for Experimental Group: 2.70
Mean for Control Group: 2.81

Table 12

Post-Test of Attitudes Towards Biology:
Analysis of Variance

Source	DF	SS	MS	F	P
Between Groups	1	0.01	0.01	0.03	0.88
Within Groups	192	76.01	0.40		
TOTAL	193	76.02			

Mean for Experimental Group: 2.79
Mean for Control Group: 2.77

separately but there was no significant difference observed when the gain scores were compared across groups, even though a positive shift was noted for the TGT group versus a negative shift for the control group.

The fourth question of the study was

4. Would high school students like TGT better as a means for studying chapter material than traditional classroom methods to which they had previously been exposed?

Students were given the teams-game attitude questionnaire on the second and seventh week of the treatment period. A dependent t-test was computed between the mean attitude score (2.24) of the second week and the mean attitude score (2.22) of the seventh week for students in experimental classes. As expected, this is not a significant difference or change in the means between week two and week seven (Table 13). With a score of "1" being the most positive response on a five point scale toward games, a score of 2.2 at week seven indicated that students maintained their attitudes towards team-games as being a good method for learning the subject matter from week two to week seven.

Summary

Collectively these results indicate that TGT had no significant effect on the biology achievement scores or attitudes towards biology of tenth-grade high school students. Analysis of the data revealed no difference between control and experimental groups on pre-test, post-test, or delayed test measures.

Table 13

Attitudes Towards Team Games

	X	SD	Difference Means	SD	S. Error	T-Value	2-Tail Prob.
Week Two	2.24	0.60	.01	0.69	0.07	0.21	0.83
Week Seven	2.22	0.77					

Chapter 5

DISCUSSION, FINDINGS

The results of this study answered the questions originally posed in Chapter 1. The findings of this study did not coincide with previous findings about TGT for several possible reasons stated in this chapter.

Discussion

The data revealed no significant difference between the control and experimental groups on any of the achievement or attitude measures used in this study.

Analysis of the dependent t-test data revealed no change in the mean attitude score between week two and week seven for students in experimental classes. Apparently the students maintained their positive attitude toward team games for the duration of the study.

The findings of the present study did not support the previous findings of DeVries and associates at Johns Hopkins concerning gains in cognitive achievement by students who had been involved in TGT studies. There are several possible reasons for this lack of congruence with previous findings:

1. This study was conducted in a high school setting as opposed to most previous studies that have involved elementary or junior high settings. The only previous TGT study conducted in a high school setting involved social studies and showed only a "marginal" significant difference between experimental and control groups (DeVries, 1978, p. 1). While TGT appears to be effective with junior high and elementary level students, this study brings into question its effectiveness at the high school level.

2. This study was conducted with students who come from an affluent community in which many parents have successful business and professional careers. Because a high percentage of parents from this community have expectations that their children will continue on to college and enter professional careers and about seventy percent of the students from this high school enter college each year, the students may be influenced by motivating factors such as parental and peer pressure to make good grades and get into college that far outweigh the effects of a teaching method such as TGT.

3. The nature of the BSCS curriculum is to promote inquiry and thinking on the part of students. BSCS test items are constructed so as to make the student take the facts and information he has learned and apply them to another problem or to think through a solution and solve a problem. BSCS tests are not altogether "recall" of information. TGT, however, has been found to work better with subjects in which retention of facts or the learning of skills is important. According to DeVries (August, 1976, p. 72), TGT has shown its best results when

used with "courses which have easily quantifiable behavioral objectives and which have concrete skill areas." Thus, the inquiry approach to science, seen in the BSCS curriculum, may not be as sensitive to the effects of the TGT method as other more quantifiable curriculum content, such as that of math or vocabulary.

4. This study involved subjects who were all grouped as general-ability students. The very exceptional high-ability student or very low-ability student were not enrolled in green-version BSCS biology at this high school. TGT research study 2 (Edwards and DeVries, 1972, p. 11) reported that low- and middle-ability students had the greatest increase in cognitive scores. Study 4 (Hulten and DeVries, 1976, p. 10), used with seventh-grade math students, involved the use of five classes designated as "below average" and five classes designated as "average." TGT research on the third-grade level with language arts (Study 6,7,8) revealed that "TGT appeared to result in greater gains for classes comprised of low-ability students" (DeVries and Mescon, 1975, p. 17). DeVries stated that "the positive TGT effect was primarily accounted for by the low- and average-achieving students" (DeVries, Mescon, Shackman, 1975, p. 11). In all of these studies no information is given as to what constitutes a "low-ability", "average" or "below average" student.

The students involved in this study ranged from 35th percentile in differential aptitude to 99th percentile. The average combined differential aptitude for all students involved in the study was 74. Of the approximately 200 students involved in the study only 14

had a differential aptitude below 55. Thus, there was no large contingent of what the school defined as "low-ability" students in this study when compared with several of the TGT studies which indicated that half of the population involved was made up of "low-ability" students.

5. There were problems inherent in the TGT gaming process, which may have influenced the results. Although students liked the team games, the teachers involved in the study did report to this investigator some disadvantages they saw in the technique. One problem noticed was that some high school students felt ill at ease when they began the competition at low-ability tables. Another problem was that sometimes, through the "bumping" procedure, members of the same team competed against each other at the same table. This was definitely detrimental to their team score since there would be no way everyone in the team could earn 6 points. A third problem emerged near the end of the study when students discovered that the team could make more points if certain students were absent. For example, the following adjusted team score shows how the team benefits by Julie's absence.

Example:	John	4
	Susie	4
	Tom	4
	Julie	absent
		12

Transformed to be equal to four member team 16

The two teachers felt that enthusiasm was very high in the beginning of the study but that students tended to lose interest in the game after six weeks. This perceived loss of interest, however, was not verified by the attitude data which indicated that experimental classes maintained a high interest in games for the duration of the study.

Findings

The results of this study support the following findings:

1. When compared to traditional classroom methods, the teams-games-tournament method (TGT) did not significantly increase the cognitive achievement scores of general-ability high school students enrolled in BSCS green version biology classes.

2. When compared to traditional classroom methods, the teams-games-tournament method (TGT) did not significantly increase, after a delay of ten weeks, the retention achievement scores of general-ability high school students enrolled in BSCS green version biology.

3. When compared to traditional classroom methods, the teams-games-tournament method (TGT) did not cause general-ability high school students enrolled in BSCS green version biology to show attitudes significantly more positive towards biology.

4. Tenth-grade general-ability high school students in BSCS green version biology liked team games as a method for studying

subject matter in biology and sustained a positive reaction to them.

It was also found that scoring and record keeping procedures for playing the game each week took four to five hours to complete. Before using this method in the classroom, teachers should consider the extra time that they will have to devote to such an endeavor above and beyond their normal teaching duties.

Recommendations

The findings of this study suggest that no further research of teams-games-tournaments be conducted with high school biology students. The failure of the procedure to produce significant advantages in student attitudes or achievement scores as compared to students in traditional classroom procedure casts doubt on the efficacy of the method for all high school science courses, given the amount of time and preparation effort needed to use the procedure.

BIBLIOGRAPHY

Allen, L. E. "EQUATIONS: A Game of Creative Mathematics." New Haven, Conn.: Wff n' Proof, 1969.

_____, R. W. Allen, and J. Ross. "The Virtues of Nonsimulation Games." Simulation and Games, 1970, 319-326.

Anderson, G. J., "Effects of Classroom Social Climate on Individual Learning," American Educational Research Journal, 1970, VII, 135-152.

_____, H. J. Walberg, and W. W. Welch. "Curriculum Effects on the Social Climate of Learning: A New Representation of Discriminant Functions." American Educational Research Journal, 1969, VI, 315-328.

Ary, Donald, Lucy C. Jacobs, and Asghar Razavich. Introduction to Research In Education. New York: Holt, Rinehart and Winston, Inc., 1970.

Atkinson, John W. A Theory of Achievement Motivation. New York: Robert Krieger Publishing Co., 1966.

Becker, H.A. "Emergency of Simulation Gaming." Simulation and Games, March, 1980, XI, No. 1, 11-25.

Boocock, S.S. Effects of Election Campaign Game in Four High School Classes, Research Program on the Effects of Games with Simulated Environments in Secondary Education. Report No. 1. Baltimore, Md: Johns Hopkins University Department of Social Relations, 1963.

_____, and C. Stoll. Simulation Games and Control Beliefs. Center for Social Organization of Schools, Report No. 10 (ERIC 016-736) Baltimore, Md: Johns Hopkins University, 1967.

_____, and E. O. Schild, eds. Simulation Games in Learning. Beverly Hills, Calif. Sage, 1968.

Bronfenbrenner, Urie. Two Worlds of Childhood. New York: Russell Sage Foundation, 1970.

Coleman, J.S. "Academic Achievement and the Structure of Competition." Harvard Educational Review, 1959, XXIX, 339-351.

_____. "Academic Games and Learning." NASSP Bulletin, February, 1968, 52(325), 62-72.

Coleman, J.S., S. A. Livingston, G. M. Fennessey, K. J. Edwards, and S. J. Kidder. "The Hopkins Games Program: Conclusions from Seven Years of Research." Educational Researcher, August, 1973, 3-7.

Deutsch, M. "An Experimental Study of the Effects of Cooperation and Competition upon Group Process." Human Relations, 1949, II, pp. 199-231.

DeVries, D.L., and K.J. Edwards. "Learning Games and Student Teams: Their Effects on Classroom Process." American Educational Research Journal, 1973, 307-318.

_____, and E.H. Wells. Teams - Games -Tournaments in the Social Studies Classroom: Effects on Academic Achievement, Student Attitudes, Cognitive Beliefs, and Classroom Climate. Center for Social Organization of Schools, The Johns Hopkins University, 1974a, Report No. 173.

_____. Team Competition Effects on Classroom Group Process. Center for Social Organization of Schools, The Johns Hopkins University, 1974b, Report No. 174.

_____. "Student Teams and Learning Games: Their Effects on Cross-Race and Cross-Sex Interaction." Journal of Educational Psychology, 1974, LXVI, 741-749.

_____, P.R. Lucasse, and S.L. Shackman. Small Group Versus Individualized Instruction: A Field Test. Center for Social Organization of Schools, The Johns Hopkins University, April, 1980, Report No. 293.

_____, and I.T. Mescon. Teams-Games-Tournament: An Effective Task and Reward Structure in the Elementary Grades. Center for Social Organization of Schools, the Johns Hopkins University, 1975, Report No. 189.

_____, and S. L. Shackman. Teams-Games-Tournament in the Elementary Classroom: A Replication. Center for Social Organization of Schools, The Johns Hopkins University, 1975a, Report No. 190.

_____. Teams-Games-Tournament (TGT) Effects on Reading Skills in the Elementary Grades. Center for Social Organization of Schools, The Johns Hopkins University, 1975b, Report No. 200.

_____, D. Muse, and E.H. Wells. The Effects on Students of Working in Cooperative Groups: An Exploratory Study. Center for Social Organization of Schools, The Johns Hopkins University, 1971, Report No. 120.

_____, and Robert Slavin. Teams-Games-Tournaments: A Final Report On The Research. Report No. 217, August, 1976, 98 pages.

_____. "Teams-Games-Tournaments (TGT): Review of Ten Classroom Experiments." Journal of Research and Development in Education, 1978, XII, No. 1, Fall, 1978, 28-38.

_____, and Keith Edwards. Expectancy Theory and Cooperation-Competition in the Classroom. August, 1974, 20 pages. Center for Social Organization of Schools, Johns Hopkins University, Baltimore, Md.

_____. "Student Teams Can Improve Basic Skills; TGT Applied to Reading." Paper presented at American Psychological Convention, Washington, D.C., September, 1976. 27 pages.

Edwards, K.J. and D.L. DeVries. The Effects of Teams-Games-Tournaments and Two Structural Variations on Classroom Process, Student Attitudes, and Student Achievement. Center for Social Organization of Schools, Johns Hopkins University, Report No. 172.

_____. Learning Games and Student Teams: Their Effects on Student Attitudes and Achievement. December, 1972. 21 pages. Center for Social Organization of Schools, Johns Hopkins University, Report No. 147.

_____, and J.P. Snyder. "Games and Teams: A Winning Combination." Simulation and Games, 1972, 247-269.

Feather, N.T. Subjective Probability and Decision Under Certainty. In Atkinson, J.W. & Feather, N.T. (Eds.) A Theory of Achievement Motivation, New York: John Wiley and Sons, Inc., 1966.

Fennessey, G. M., S.A. Livingston, K.J. Edwards, S.J. Kidder and A.W. Nafziger. "Simulation Gaming and Coventional Instruction: An Experimental Comparison." Simulation and Games, November, 1975, 6(3), 288-302.

Fletcher, J.L. "The Effectiveness of Simulation Games as Learning Environments." Simulation and Games, 1971, 425-454.

Hulten, B.H. "Games and Teams: An Effective Combination in the

Classroom." Paper presented at the annual meeting of the American Research Association, Chicago, April, 1974.

_____, and David L. DeVries. Team Competition and Group Practice: Effects on Student Achievement and Attitudes. Report No. 212, 1976, 39 pages.

Johnson, D.W., and R.T. Johnson. "Instructional Goal Structure: Cooperative, Competitive, or Individualistic." Review of Educational Research, 1974, 213-240.

Livingston, S.A. The Academic Games Program: A Summary of Research Results (1967-1972). Johns Hopkins University, Center for the Study of the Social Organization of Schools, December, 1972.

Lott, A.J. and B.E. Lott. "Group Cohesiveness as Interpersonal Attraction: A Review of Relationships with Antecedent and Consequent Variables." Psychological Bulletin, 1965, 259-309.

Lucas, L.A., Charles Postma, and Jay Thompson. "A Comparative Study of Cognitive Retention using Simulation Gaming as Opposed to Lecture-Discussion Techniques." Peabody Journal of Education, 52:261-6, July, 1975.

Nie, N.H., C.H. Null, Jean Jenkins, Karin Steinbrenner, and Dale Bent. Statistical Package for the Social Sciences. New York: McGraw-Hill, 1975.

Pierfy, David. "Comparative Simulation Game Research Stumbling Blocks and Stepping Stones." Simulation and Games, 1977, VIII, No. 2, 255-268.

Postma, C. "Simulation in High School Social Studies: Students' Cognitive Retention and Public-Teacher Affective Perceptions." Doctoral Dissertation, Ball State University, 1973.

Reiser, R.A., and V.S. Gerlach. "Research on Simulation Games in Education: A Critical Analysis." Paper presented at the American Educational Research Association Convention, San Francisco, April, 1976.

Russell, James and Steven Hollander. "A Biology Attitude Scale." The American Biology Teacher, May, 1975, 270-273.

Slavin, Robert. "Student Teams and Achievement Divisions. Journal of Research and Development in Education, 1978, XII, No. 1, 39-49.

_____. Student Teams and Achievement Divisions: Effects on Academic Performance, Mutual Attraction, and Attitudes. Report No. 233. Johns Hopkins University, August, 1977, 25 pages.

_____. Classroom Reward Structure: An Analytical and Practical Review. Johns Hopkins University, December, 1975. 36 pages.

_____. "Cooperative Learning." Review of Educational Research. Summer, 1980, L, No. 2, 315-342.

_____. Teams-Games-Tournaments. A Student Team Approach to Teaching Adolescents With Special Emotional and Behavioral Needs. Johns Hopkins University, Center for Social Organization of Schools. November, 1975. 32 pages, Report No. 206.

_____. Using Student Team Learning. The Johns Hopkins University Press, 1978.

Spilerman, S. "Raising Academic Motivation in Lower Class Adolescents: A Convergence of Two Research Traditions." Sociology of Education, 1971, XLIV, 103-118.

Stadsklev, R. "A Comparative Study of Simulation Gaming and Lecture-Discussion Method." M.A. Thesis, Northern State College, 1969, 118 pages.

Twelker, P.A. "Some Reflections on Instructional Simulation and Gaming." Simulation & Games, 1972, III, 147-153.

Walberg, H.J., and G.J. Anderson. "Classroom Climate and Individual Learning." Journal of Educational Psychology, 1968, LIX, 414-419.

Zuckerman, D.W., and R.E. Horn, The Guide to Simulation Games for Education and Training, Lexington, Mass.: Information-Resources, Inc., 1973.

APPENDIX A

COGNITIVE PRE-TEST

PRE-TEST

BSCS Green Version Biology
TEST
Section II

No._____

Carefully read each question. After you have selected an answer from the choices given, blacken in your answer for each question on the separate answer sheet provided.

Example:

1. All dogs have (A) feathers (B) scales (C) hair (D) leaves

Answer:

1. A B C D

Please do not write on the test itself, but place all your answers on the separate answer sheet.

1. In the light reaction of photosynthesis, light energy is (A) absorbed by chlorophyll and transformed into chemical energy. (B) trapped and three carbon sugars are formed. (C) used to produce carbon dioxide. (D) used to produce glucose.

2. Carbohydrates contain all of the following EXCEPT (A) oxygen. (B) hydrogen. (C) phosphorus. (D) carbon.

3. The synthesis and breakdown of compounds in living things depends on the (A) presence of facts. (B) absence of proteins. (C) presence of enzymes. (D) absence of carbohydrates.

4. The energy most directly available for use by living cells is stored in (A) ATP. (B) sugars. (C) ADP. (D) fats.

5. Fermentation is an important process because in fermentation (A) enzymes are required. (B) free oxygen is made available. (C) all the energy available in carbohydrates is released. (D) energy can be released in the absence of oxygen.

For the next 4 items used the following key.

KEY: A. Proteins B. Nucleic acids C. Both of these
D. Neither of these

6. Building blocks are amino acids

7. Enzymes are required for their synthesis

8. Always contain nitrogen

9. Always contain a phosphate group

---

10. The energy in foods used by living things can be traced to (A) light energy. (B) chemical energy. (C) heat energy. (D) mechanical energy.

11. The green alga, Chlorella, is often mentioned as part of the equipment to be taken along on spaceships because Chlorella will provide (A) food and CO_2. (B) food and O_2. (C) only CO_2. (D) only O_2.

12. A small fish was placed in a beaker of water containing bromothymol blue. Within one hour the water became yellow. The change indicates that bromothymol blue turns yellow with a/(an) (A) decrease of CO_2. (B) decrease of O_2. (C) increase of CO_2. (D) increase of O_2.

13. The production of carbon dioxide by yeast cells during fermentation increases as the temperature of the yeast culture is raised from 30° to 40° C. This increase in production would NOT continue if the temperatures were raised further because (A) glucose could be used up. (B) oxygen could be consumed. (C) enzymes could be overproduced. (D) enzymes could be destroyed.

The next 3 items refer to the following selection from the work of an early investigator.

"a sprig of a nettle plant was put in a jar full of air fouled by breathing so as to extinguish a candle; it was placed in a room during the whole night; the next morning the air was found to be as bad as before. At 9 o'clock in the morning the jar was put in the sunshine and in the space of two hours the air was so much corrected that it was found to be nearly as good as common air."

14. The "jar full of air fouled by breathing" probably contained an excess of (A) oxygen. (B) water. (C) carbon dioxide. (D) carbon monoxide.

15. What process in the plan produces air nearly as good as "Common air"? (A) Respiration (B) Photosynthesis (C) Circulation (D) Bacterial action.

16. The substance produced by the plant whch improved the air in the jar was (A) oxygen. (B) water. (C) carbon dioxide. (D) hydrogen.

---

17. A plant that has thick fleshy stems, few or no leaves, and an extensive root system, probably grows in a climate that is (A) dry. (B) humid. (C) hot. (D) cold.

18. Which of the following is absorbed through the root hairs of plants? (A) Proteins (B) Carbohydrates (C) Oxygen (D) Carbon dioxide.

19. One reason why mosses are small is probably their (A) lack of cell walls. (B) lack of a conducting system. (C) small leaf like structures. (D) general lack of true roots.

20. The primary function of xylem and phloem is (A) absorption. (B) storage. (C) conduction. (D) photosynthesis.

21. Most of the water absorbed by a green land-plant is used to (A) supply a source of hydrogen in metabolic reactions. (B) replace water lost through transpiration. (C) combine with CO_2 in photosynthesis. (D) transport dissolved CO_2 to the cells of the plant.

22. Which of the following observations best indicates that something in addition to atmospheric pressure is responsible for the rise of water in plant stems? (A) plants grow to heights of 100 meters. (B) plants continually carry on transpiration. (C) plants will not grow unless supplied with water. (D) the tubules in plant vascular systems are thick-walled.

23. Growth in diameter of a stem of a woody plant is due to cell divisions in the (A) xylem. (B) phloem. (C) bark. (D) cambium.

24. The most probable reason why an excessive amount of fertilizer, when added to the soil near a plant root, may contribute to the death of the plant is (A) too much of one kind of mineral may be taken into the plant. (B) excess fertilizer mineral concentration may cause loss of water from the plant by osmosis. (C) the fertilizer minerals may crystallize around the root and prevent water intake. (D) the fertilizer minerals may react with the soil to form caustic compounds.

25. A plant which has leaves with a very thick cuticle would have some survival advantages in the (A) temperate forests. (B) deserts. (C) tropical rain forest. (D) pond communities.

26. One of the factors necessary for the evolution of tall vascular plants, giant ferns and trees, was (A) large green leaves. (B) an effective water conducting system. (C) a rapid rate of growth. (D) an increase in root pressure.

27. Colonization of land by plants occurred as structures evolved for (A) support and prevention of excess drying. (B) circulation and protection from the sun. (C) production and distribution of food. (D) gas exchange and cooling.

28. Plants growing in very hot and arid climates have greatly reduced photosynthetic activity during the middle hours of the day. What is the best explanation for this? (A) no water is available for the light reaction. (B) When the rate of transpiration is very high, the stomates of the leaves close, thus no CO_2 can enter the leaf. (C) the enzymes of the dark reaction are inactivated by the high temperature. (D) The wave length of the light is not suitable for photosynthesis.

29. If all green plants were to suddenly disappear, which of the following substances normally found in the atmosphere would probably be first to be used up? (A) CO_2 (B) N_2 (C) H_2O vapor (D) O_2.

30. The loss of water by a green plant is controlled mainly by (A) guard cells. (B) palisade cells. (C) epidermal cells. (D) spongy layer cells.

31. Xylem and phloem are found in all land plants EXCEPT (A) ferns. (B) mosses. (C) conifers. (D) flowering plants.

32. The loss of water by a plant is called (A) phototropism (B) cohesion (C) transpiration (D) geotropism.

---

33. The red blood cells are primarily responsible for (A) clotting. (B) transporting food. (C) transporting oxygen. (D) killing invading bacteria.

34. Nervous coordination differs from endocrine coordination in that the nervous coordination is (A) slower. (B) less specific. (C) faster. (D) controlled by hormones.

35. The only vessels in the circulatory system which will allow molecules to diffuse across them readily are (A) capillaries. (B) veins. (C) arteries. (D) lymph vessels.

36. A captured baby rabbit was placed in a cage; its heartbeat increased every time it was picked up. This response was probably due to secretion of the (A) adrenal gland. (B) parathyroid gland. (C) pancreas gland. (D) thyroid gland.

37. If a nerve in a frog's leg was stimulated electrically and the only reaction was a contraction of the muscles in the same leg, the nerve was most likely (A) a motor nerve. (B) a mixed motor and sensory nerve. (C) a sensory nerve. (D) an associative nerve.

38. Normally the substance almost completely reabsorbed and returned to the bloodstream from the human kidney is (A) urea. (B) water. (C) glucose. (D) Uric acid.

39. Essentially digestion means (A) burning food for energy. (B) building up proteins from amino acids. (C) changing organic molecules. (D) breaking large molecules into smaller ones.

40. Where is the most common place of attachment for human striated muscles? (A) Skin (B) Bones (C) Heart (D) Digestive tract.

41. In mammals the wall of the left ventricle is thicker than that of the right ventricle. This is an adaptation due to the fact that the left ventricle (A) is smaller than the right ventricle. (B) receives only blood low in oxygen content. (C) pumps blood to the lungs. (D) pumps blood to all the extremities of the body.

42. The principal effect of hormone of the thyroid is to increase the (A) metabolic activities of all cells. (B) metabolic activities of the cells of the liver. (C) body weight. (D) sugar in the urine.

43. The fundamental unit of all nervous systems is the (A) reflex. (B) nerve fiber. (C) neuron. (D) nerve net.

44. The components of mammaliam blood, most directly involved in combating bacterial infections are (A) red blood cells and antibodies. (B) platelets and antibodies. (C) white blood cells and antibodies. (D) white blood cells and red blood cells.

45. The small intestine is adapted for sufficient absorption of digested food because it has (A) a good nerve supply. (B) short length. (C) muscular walls to move the food along. (D) folds and villi.

46. Food molecules absorbed from the intestine are carried throughout the body in (A) white blood cells. (B) plasma. (C) red blood cells. (D) hemoglobin.

47. Artery walls are more elastic and muscular than the walls of veins, therefore artery walls (A) withstand the pressure created by the heart's pumping. (B) equalize the pressure throughout the arterial system. (C) insure no loss of blood plasma. (D) keep the white cells from escaping.

48. Where does most digestion occur? (A) mouth. (B) stomach. (C) small intestine (D) large intestine.

49. A characteristic of all respiratory systems is (A) thin, moist membranes. (B) lungs. (C) gills. (D) tracheal tubes.

50. The kidneys excrete the end products of metabolism and (A) of digestion. (B) control the concentration of substance in the body fluids. (C) of substances used in the digestive system. (D) regulate bile secretion.

END

APPENDIX B

COGNITIVE POST-TEST

BSCS Green Version Biology
TEST
Chapters 12, 13, 14

No._____

Carefully read each question. After you have selected an answer from the choices given, blacken in your answer for each question on the separate answer sheet provided.

Example:

1. All dogs have (A) feathers. (B) scales. (C) hair. (D) leaves.

Answer:

1. A B C D

Please do not write on the test itself, but place all your answers on the separate answer sheet.

The next 5 items refer to enzymes. Use the key to classify specific features of the way that they work.

KEY: A. True of all enzymes
B. True of some enzymes
C. Not true of enzymes

1. Catalyze a specific reaction

2. Act best at very high temperatures

3. Produced by cells

4. Act as catalysts

5. Optimum temperature at which the enzymes acts is 98.6° F.

For the next 10 items use the following key to identify the process described in each statement.

KEY: A. Respiration (Krebs cycle)
B. Fermentation and (glycolysis)
C. Both of these
D. Neither of these

6. Can occur in the absence of oxygen

7. Oxygen is used

8. May produce alcohol

9. Occurs in mitochondria

10. Pyruvic acid is formed

11. Occurs as a series of reactions rather than as a single reaction

12. Enzymes are involved in the reaction

13. Synthesis of ATP is involved in the reaction

14. Energy is released

15. Pigments are necessary

The next 5 items refer to comparisons of the light and dark reactions in photosynthesis. Use the following key.

KEY:
A. Occurs in the light reaction
B. Occurs in the dark reaction
C. Occurs in both reactions
D. Does not occur in either reaction

16. Radiant energy is absorbed.

17. Oxygen is used.

18. Chlorophyll is involved.

19. Reactions are catalyzed by enzymes.

20. Oxygen is produced.

The next 7 items refer to various possible conditions in a plant's environment. Indicate how transpiration would be affected for each condition.

KEY: The condition described would
A. increase transpiration.
B. decrease transpiration.
C. not be predictable.

21. The light intensity doubles.

22. The air temperature increases from 20° to 25° C.

23. The stomates on the upper surfaces become clogged with cooking oils.

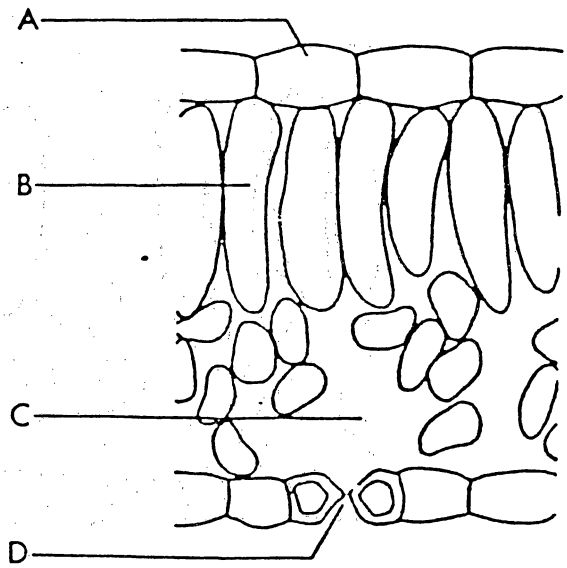
24. After many weeks of growth in a dark corner, the leaves doubled in size.

25. A bell jar is placed over the plant.

26. The soil water is depleted.

27. The sky becomes very cloudy.

Use the following key to answer the next 8 items about the function of various leaf parts.



28. Where carbon dioxide enters the leaf

29. Where carbon dioxide is utilized

30. Where photosynthesis occurs

31. Where oxygen leaves the leaf

32. Where there are large numbers of chloroplasts

33. Where most of the light energy enters

34. Where glucose is produced

35. Where most of the water leaves the leaf

---

36. The vascular tissue which conducts water in an advanced plant is (A) phloem. (B) Xylem. (C) pith. (D) cambium.

37. The bending of stems toward light is due to uneven growth of cells caused by (A) enzymes. (B) auxins. (C) gibberelic acid. (D) proteins.

38. A plant needs to take in which of the following to carry on photosynthesis? (A) water, oxygen, and sunlight. (B) oxygen, carbon dioxide, and sunlight. (C) carbon dioxide, sugar, and sunlight. (D) carbon dioxide, water, and sunlight.

39. The chief supporting cells of a stem of a woody plant are found in the (A) bark. (B) xylem. (C) phloem. (D) cambium.

40. In a greenhouse, young corn plants are grown under optimal conditions of soil, temperature, and humidity. Which procedure would increase the rate of photosynthesis? (A) Adding magnesium to the soil. (B) Adding ATP and Mg to the soil. (C) Increasing the O_2 content of the atmosphere. (D) Increasing the CO_2 content of the atmosphere.

The next 4 items are to be classified using the following key listing endocrine glands.

KEY:
A. Adrenal gland
B. Parathyroid
C. Pituitary
D. Thyroid

41. Produces a hormone functioning in calcium metabolism.

42. Produces a hormone regulating the rate of cellular metabolism.

43. Controls secretion of other endocrine glands.

44. Regulates blood circulation and affects blood clotting.

Use the key below for the next 6 items.

KEY: A. A characteristic of bone only.

B. A characteristic of muscle only.
C. A characteristic of both bone and muscle.
D. A characteristic of neither bone nor muscle.

45. Living tissue

46. Provides support for the body

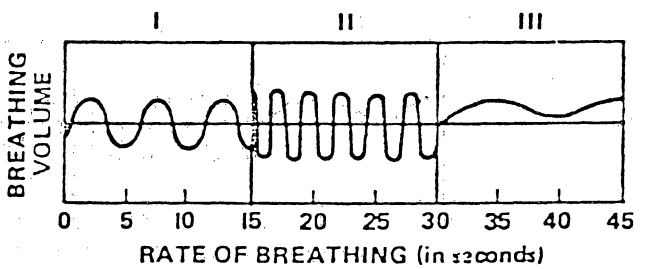
47. Provides protection for the body

48. Aids in locomotion

49. Movement is at joints

50. Exhibits contractility

The next 3 items relate to breathing rates of a man under 3 different conditions.

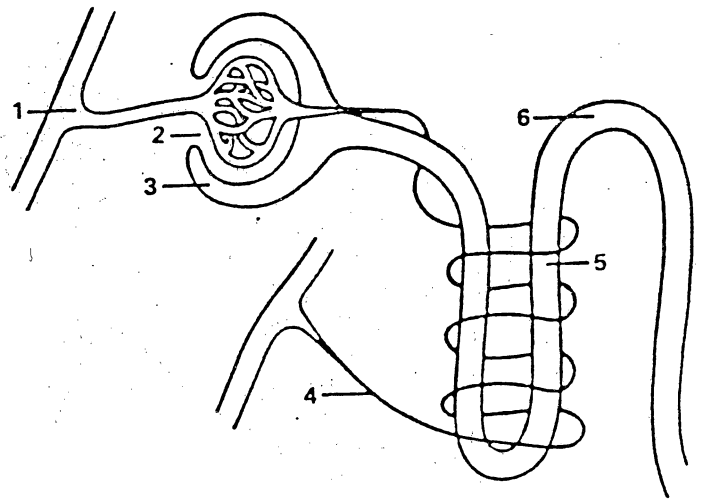


51. Which section of the graph(s) indicates a process of replacing the greatest oxygen deficiency? (A) I. (B) II. (C) III. (D) I and III.

52. What would be the order of the graph sections which demonstrate sleep, climbing stairs, and reading? (A) I, II, III. (B) I, III, II. (C) III, I, II. (D) III, II, I.

53. Which graph(s) show the normal breathing rate for this man? (A) I. (B) II. (C) III. (D) II and III.

The next three items are based on the following diagram of a human excretory unit.



54. The structure into which the filtrate first passes. (A) 1. (B) 2. (C) 3. (D) 5.

55. The structure which carries urine toward a ureter. (A) 1. (B) 2. (C) 4. (D) 6.

56. The area from which water is reabsorbed. (A) 2. (B) 3. (C) 5. (D) 6.

For the next 4 items use the key to indicate in which region of the human digestive tract the following processes occur.

KEY: A. Mouth
B. Esophagus
C. Stomach
D. Small intestine

57. Chemical digestion begins

58. Absorption of all food types takes place

59. Physical breakdown of food begins

60. Protein digestion begins

END

APPENDIX C

BIOLOGY ATTITUDE TEST

BIOLOGY ATTITUDE TEST
(Russell and Hollander, 1975)
Purdue University

Each of the statements below expresses a feeling toward biology. Please rate each statement on the extent to which you agree. For each, you may (A) stronly agree, (B) agree, (C) be undecided, (D) disagree, or (E) strongly disagree.

After you have mae your choice, blacken in the appropriate response in the space on the separate answer sheet provided.

A	B	C	D	E
Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree

1. Biology is very interesting to me.
2. I don't like biology, and it scares me to have to take it.
3. I am always under a terrible strain in a biology class.
4. Biology is fascinating and fun.
5. Biology makes me feel secure, and at the same time it is stimulating.
6. Biology makes me feel uncomfortable, restless, irritable, and impatient.
7. In general, I have a good feeling toward biology.
8. When I hear the word biology, I have a feeling of dislike.
9. I approach biology with a feeling of hesitation.
10. I really like biology.
11. I have always enjoyed studying biology in school.
12. It makes me nervous to even think about doing a biology experiment.
13. I feel at ease in biology and like it very much.
14. I feel a definite positive reaction to biology; it's enjoyable.

APPENDIX D

TEAM-GAMES ATTITUDE TEST

TEAM-GAMES ATTITUDE TEST
(Russell and Hollander, 1975)
Purdue University

Each of the statements below expresses a feeling toward team games. Please rate each statement on the extent to which you agree. For each, you may (A) strongly agree, (B) agree, (C) be undecided, (D) disagree, or (E) strongly disagree.

After you have made your choice, blacken in the appropriate response in the space on the separate answer sheet provided.

A	B	C	D	E
Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree

1. Team-games are very exciting to me.
2. I don't like team-games, and it scares me to have to participate in them.
3. I am always under a terrible strain during a team-game.
4. Team-games are fascinating and fun.
5. Team-games make me feel secure; and at the same time they are stimulating.
6. Team-games make me feel uncomfortable, restless, irritable, and impatient.
7. In general, I have a good feeling toward team-games.
8. When I hear the words "team-games", I have a feeling of dislike.
9. I approach team-games with a feeling of hesitation.
10. I really like team-games.
11. I have always enjoyed team-games in school.
12. It makes me nervous to even think about team-games.
13. I feel at ease in team-games and like them very much.
14. I feel a definite positive reaction to team-games; they're enjoyable.

APPENDIX E

LESSON PLANS FOR THE SEVEN WEEK STUDY

LESSON PLANS

February 4, 5, 8-12

Wednesday and Thursday

1. Begin handout sheets on Chapter 12 - Terms

Friday - Short PM Schedule

1. Chapter 12 - Chemistry terms - (handout sheets)
2. Assign them to read Lab 12.2 for homework and pp. 369-372
3. Give out worksheets for them to do on chapter. Have them work on them as they read the assignment.

Monday

1. Discuss pp. 369-372
2. Continue simple chemistry - atom, molecule, compound, mixture, element (handout sheet)
3. Assign Lab 12.2 to read for homework. Introduce Lab and prep.

Tuesday

1. Lab: 12.2 - Liver and Potatoe; Enzymes
(Give them Lab chart to fill in); Go over questions if time permits

Wednesday

1. Discuss Lab 12.2; Go over questions if haven't before
2. Assign them to read pp. 369-384
3. Go over handout sheet on Carbohydrates, fats, lipids, DNA. Go as far as possible.

Thursday

1. Continue discussion of Carbohydrates, Fats, Lipids, DNA (handout)
2. Go over handout on Cellular Respiration - Glycolysis
Krebs
Cytochrome System
3. Team Practice for Experimental pp. 369-384. Control: Have them do work sheet for pp. 369-384; check if time permits

Friday

Experimental:	Control:
1. Games on Chapter 12 (TGT) pp. 369-384	1. Check worksheet.
	2. Question and Answer Period on Chapter 12, pp. 369-384
2. Assign them to read pp. 384-395 and begin doing worksheets as they read	3. Go over worksheet
	4. Give Quiz?
	5. If time - let them begin reading pp. 384-395 and do worksheet
3. Announce test for next Friday.	6. Announce test for next Friday.

LESSON PLANS

February 15-19

Monday

1. Lab: Testing for compounds in food
2. Assign them to read pp. 384-396 and do worksheet
3. Remind them of test on Friday.

Tuesday

1. Finish discussion of carbohydrates, fats, lipids, DNA, RNA.
2. Introduce photosynthesis
   $6\ CO_2 + 6\ H_2O$---------- $C_6H_{12}O_6 + 6O_2$
3. Go over dark and light reactions - Explain differences.
4. Prep LAB on Chromatography - Assign them to read for homework.

Wednesday

LAB 12.4 - Chromatography and Leaf Pigments
Tell them to hand in questions on lab tomorrow
Team Practice in Experimental Classes over worksheet.

Control: Finish up worksheets. Check them. Begin going over.

Thursday

1. Take up LAB 12.4 - Questions of lab
2. GAMES on Chaper 12 / or in Experimental

Control: Go over worksheet questions. Give quiz for practice. Question-Answer Period on Chapter 12.

Friday

1. TEST on Chapter 12
2. Assign them to begin reading Chapter 13 - Functioning Plants pp. 399-407.
3. Give them new worksheets for Chapter 13. Have them work on them as they read homework assignment.

LESSON PLANS

February 22-26

Monday

1. Introduce Chapter 13 - pp. 399-406. Discuss functions of leaves, stomates, etc.
2. Assign them to read LAB 13.2 for Tuesday - pp. 407-408.
3. Filmstrip - "Function of Leaves" (If time permits)

Tuesday

LAB 13.2. - Stomates and Photosynthesis
Go over questions of Lab
Assign pp. 407-419

Wednesday

1. Give them diagrams of cross sections of leaves, roots stems - Go over briefly
2. Discuss pp. 407-419 on Roots; Stems
3. Filmstrip - "Functions of Roots" (Only if time allows)
4. LAB - Prepared slides - Begin.

Thursday

LAB - Prepared Slides

1. Roots, Stems, Leaves - Have them answer questions concerning these slides
2. Wood Stem - count rings
3. Branch - Locate terminal bud, lateral bud, lenticel.
4. Team Practice in Experimental Classes / Work on worksheet in on pp. 399-419. control class. Check them. Begin going over worksheet if time permits.

Friday

Experimental:	Control:
1. Games on chapter pp. 399-419 or/	1. Go over worksheets
	2. Question-Answer Period on chapter pp. 399-419
	3. Quiz

2. Assign pp. 421-429 for homework and have them work on worksheet questions that apply to these pages.

4. Assign pp. 421-429 for homework.
5. Have them begin this reading assignment if time permits and work on worksheets.

LESSON PLANS

March 1-5

Monday

1. LAB on Prepared Slides - finish up
2. Discuss pp. 421-429 - Plant Hormones; Phototropism
   Experiments of a) Darwin
   b) Boysen-Jensen
   c) Frits Went
   d) H. H. Dixon
3. Announce Test for Friday

Tuesday

1. Continue discussion of chapter.

Wednesday

1. Finish up - tie up loose ends of chapter; all terms
2. Team Practice in Experimental Classes / Work on worksheet in control.
   Check worksheet
   Begin going over if time permits.

Thursday

Experimental:

1. GAMES on Chapter 13
2. Remind of TEST Friday

Control:

1. Go over Worksheets
2. Give Quiz
3. Question-Answer Period on Chapter 13
4. Remind them of TEST Friday.

Friday

1. TEST on Chapter 13
2. Assign Chapter 14 - pp. 435-442. Introduce chapter.
3. Give them worksheets for Chapter 14 and have them work on them as they do reading assignment for homework.

LESSON PLANS

March 8-12

Monday

1. Lab: Digestion of Protein
   Use capillary tubes, pepsin, egg whites
2. Assign pp. 443-464 in text for reading and have them work on appropriate questions from worksheet.

Tuesday

1. Lab on digestion - go over
2. Discuss chapter - pp. 435-442: Fill in diagrams of digestive system.
3. Show filmstrip on "Digestive System"
4. Assign pp. 443-464 again for homework. Have them read lab 14.3.

Wednesday

Lab 14.3 - A Heart At Work
(Daphnia)
Hot water, Cold water - go over questions of lab.

Thursday

1. Fill in diagram of respiratory system and heart
2. Discuss respiration in different animals; circulation in different animals; terms of 443-464
3. Team practice in Experimental Classes / Work on worksheet in control
   Check worksheets

Friday

Experimental:

1. GAMES on Chapter 14 - pp. 435-464
2. Assign pp. 464-472 for them to read and have them answer questions from worksheet on those pages.

Control:

1. Question-Answer Period on chapter pp. 435-464
2. Quiz
3. Go over worksheets
4. Assign pp. 464-472 and have them work on questions from worksheet.

LESSON PLANS

March 15-19

Monday

1. Fill in diagram of excretory system; glands
2. Filmstrips: "Excretion"
   "The Glands"
   (They must fill in sheet as they watch filmstrip)
3. Discuss muscles bones, nervous system - pp. 464-473
4. Assign test on Chapter 14 for Monday.

Tuesday

1. LAB 14.1 - Frog Dissection - Begin

Wednesday

LAB: Frog Dissection
(Continue)

Thursday

1. Give lab practical on frog
2. Tie up loose ends of Chapter 14
3. Team practice in Experimental Classes / Work on worksheet in control.
   Check worksheet
   Begin going over worksheet if time permits.

Friday

Experimental:
GAMES On Chapter 14 or /

Control:
1. Go over worksheet
2. Question-Answer Period on Chapter 14
3. Quiz?

LESSON PLANS

March 22-26

Monday

1. Test on Chapter 14
2. Assign Chapter 16 - pp. 519-524 for homework.

Tuesday

1. Phase I Test on Chapters 12, 13, 14.
2. Assign them to read Lab 16.3 - Chick Embryology - pp. 545-549.

Wednesday

1. LAB: Chick Embryology
   Open - Unincubated egg
   Two day embryo - DRAW
   Answer questions 1-12
2. Finish discussion of asexual reproduction
3. Assign pp. 524-536 for homework.

Thursday

GAMES pp. 519-536 or/ Question-Answer Period pp. 519-536

Friday

1. LAB: Chick Embroyology
   Open 5 - Day Embryo - DRAW
   Answer Questions 13-18
2. Meiosis - Go over Diagram - Explain.

APPENDIX F

OBJECTIVES FOR CHAPTERS 12,13,14

Unit Title: Bioenergetics

Text Reference: Green Version Biology
Chapter 12, Pages 369-398

Objectives

After completing this unit, the student should be able to

1. explain the need organisms have for energy.
2. understand the concept of a calorie.
3. distinguish the difference and similarity between catalysts and enzymes.
4. explain the main reactions occurring in cellular respiration.
5. describe how the ADP-ATP cycle occurs.
6. recognize the formula for glucose.
7. describe the use of glucose in cells.
8. explain the use of carbohydrates, fats, proteins, and nucleic acids in cells.
9. explain what foods provide glucose, carbohydrates, fats and proteins.
10. recognize how the DNA molcule is constructed and replicates.
11. summarize the process of photosynthesis in a chemical equation.
12. differentiate between the light reaction and dark reaction of photosynthesis.

Activities

Lectures
Brief notes on main ideas and structures in the chapter

Lab
12.2 A Study of Biochemical Reactions
12.4 Separation of Leaf Pigments

Audio-Visual Materials

Filmstrip - "Macromolecules in Biology"
Films: "Matter and Energy"
"Cell Biology: Life Functions"

Unit Title: The Functioning Plant

Text Reference: Green Version Biology
Chapter 13, Pages 399-430

Objectives

After completing this unit, a student should be able to

1. name the three organs of vascular plants and the main functions of each.
2. distinguish between the blade and the petiole of simple and compound leaves.
3. label the tissues and structures of a leaf cross-section and relate this structure to the function of photosynthesis.
4. explain the function of guard cells.
5. label a diagram of a dormant woody twig.
6. label a diagram of a tree trunk cross-section, showing xylem, cambium, phloem, heartwood, sapwood and annual rings.
7. describe the formation of annual rings.
8. explain H.H. Dixon's transpiration-tension theory for explaining the rise of liquids in plant stems.
9. point out four meristems on a plant.
10. explain the role of Auxin in phototropism.
11. explain Boysen-Jenson's experiments.
12. Name several natural and man-made chemicals that affect plant growth.
13. explain briefly the structures of a chloroplast.
14. name the four different kinds of chlorophyll.

Activities

Lab

1. Prepared Slides with Questions: Roots, Stems, Leaves

2. Stomate lab: Stomates and Photosynthesis

3. Rate of Growth - 13.4

Lecture

1. Movies: Plant Traps, Plant Motions, Roots of Plants

2. Notes on chapter

Audio-Visual Materials

1. Movies: Plant Traps, Plant Motion, and Roots of Plants (state)

2. BSCS Filmloops: Phototropism, - Biology stockroom

3. Filmstrips - "Roots"; "Stems"; "Leaves"; "Plant Hormones"

Unit Title: The Functioning Animal

Text Reference: Green Version Biology
Chapter 14, pages 431-478

Objectives

After completing the unit, student should be able to

1. use careful dissection techniques and identify the major external and internal structures of the frog.
2. name and explain the three states of nutrition.
3. identify and give the function of the major digestive structures in man and label a diagram of major organs of the digestive system.
4. summarize chemical digestion in man.
5. name four ways animals obtain oxygen.
6. identify and give the functions of the major respiratory structures in man and label a diagram of major organs.
7. be able to distinguish between an open and a closed circulatory system.
8. give the functions of the four kinds of vessels in a vertebrate circulatory system: heart, arteries, veins, and capillaries.
9. explain the functions of the atria and the ventricles.
10. name and give the functions of the four major components of human blood.
11. label a diagram of the parts of the heart and trace the path-way of blood through the heart.
12. trace the process of clotting.
13. explain the function of the lymph system and its components.
14. explain the effect of varying environmental temperature on the heartbeat of an animal. (Daphnia lab)
15. define and explain the differences between excretion, secretion, and elimination.

16. list three ways in which animals excrete water and other wastes.

17. list the steps involved in converting protein wastes to urea, and explain the three processes that occur in the kidney.

18. trace the path of urine from the glomerulus to the urethra and explain how the nephron works.

19. label a diagram of the urinary system.

20. name the two systems that maintain internal homeostasis.

21. define the terms "hormone" and "endocrine." Explain the difference between regular glands and endocrine glands.

22. name the seven major endocrine glands and give the effect of the major hormone produced by each. Give the diseases and conditions that result if the endocrine glands oversecrete or undersecrete.

23. state the functional differences between the three types of neurons in mammals and explain the reflex arc.

24. define a synapse and explain how an impulse passes from one neuron to the next.

25. explain the function of the autonomic nervous system.

26. explain how an organism adjusts to changes in his external environment.

27. name the three general types of muscle tissue and explain their differences.

28. explain the relationship of muscles and skeletons in arthropods and in chordates.

Activities

Lectures

1. Filmstrips on Digestion and Respiration plus sheets to fill in.
2. Lecture on circulatory system plus movie- "Work of the Heart"
3. Filmstrips on Urinary System and Endocrine System plus sheets to fill in
4. Filmstrips + cassette tapes + lecture
   "Brain + Senses"
   Lecture on parts of brain

Labs

1. Dissection of the Frog; Lab Practical
2. Lab on Perception of Taste
3. Lab 14.3 - Daphnia - A Heart at Work
4. Skeleton Lab
5. Digestion of Protein

Audio-Visual Materials

1. Filmstrips - "Digestion"
   "Respiration"
   "Excretion"
   "Endocrine System"
   "Circulatory System"
   "Reproduction" - school library
2. Movie - "The Work of the Heart" - County AV Center
3. Filmstrip Set - "The Brain" - school library

APPENDIX G

PRORATING SCORE SHEET FOR TGT

APPENDIX B. PRORATED SCORES FOR TEAMS WITH TWO, THREE, OR FIVE MEMBERS

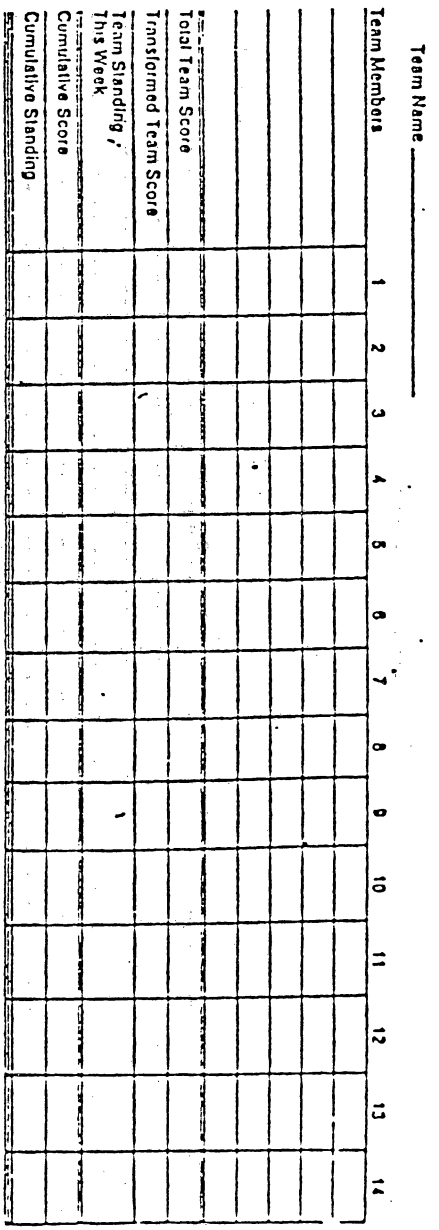
Raw Scores	Five-Member Team	Three-Member Team	Two-Member Team
4			8
5			10
6		8	12
7		9	14
8		11	16
9		12	18
10	8	13	20
11	9	15	22
12	10	16	24
13	11	17	26
14	12	19	28
15	12	20	30
16	13	21	32
17	14	23	34
18	14	24	36
19	15	25	38
20	16	27	40
21	17	28	
22	18	29	
23	18	31	
24	19	32	
25	20	33	
26	21	35	
27	22	36	
28	22	37	
29	23	39	
30	24	40	
31	25		
32	26		
33	26		
34	27		
35	28		
36	29		
37	30		
38	30		
39	31		
40	32		
41	33		
42	34		
43	34		
44	35		
45	36		
46	37		
47	38		
48	38		
49	39		
50	40		

33

(From: Using Student Team Learning by Robert Slavin, The Johns Hopkins University Press, 1978, p. 33)

APPENDIX H

TEAM SUMMARY SHEET FOR TGT



(From: Using Student Team Learning by Robert Slavin
The Johns Hopkins University Press, 1978, p. 47)

APPENDIX I

TOURNAMENT SCORE SHEET FOR TGT

TOURNAMENT SCORE SHEET (TGT)

		Tournament Number:												
Student	Team	1	2	3	4	5	6	7	8	9	10	11	12	13

(From: <u>Using Student Team Learning</u> by Robert Slavin, The Johns Hopkins University Press, 1978, p. 46)

APPENDIX J

GAME SCORE SHEET FOR TGT

GAME SCORE SHEETS

TABLE NO. ________ GAME SCORE SHEET

PLAYER	TEAM	Game 1	Game 2	Game 3	DAY'S TOTAL	TOURNAMENT POINTS

TABLE NO. ________ GAME SCORE SHEET

PLAYER	TEAM	Game 1	Game 2	Game 3	DAY'S TOTAL	TOURNAMENT POINTS

TABLE NO. ________ GAME SCORE SHEET

PLAYER	TEAM	Game 1	Game 2	Game 3	DAY'S TOTAL	TOURNAMENT POINTS

TABLE NO. ________ GAME SCORE SHEET

PLAYER	TEAM	Game 1	Game 2	Game 3	DAY'S TOTAL	TOURNAMENT POINTS

(From: Using Student Team Learning by Robert Slavin,
The Johns Hopkins University Press, 1978, p. 45)

APPENDIX K

SAMPLE TOURNAMENT SCORE SHEET FOR TGT WITH "BUMPING" METHOD

SAMPLE

Figure 8. Sample Tournament Score Sheet With Bumping (Five Tournament Tables)

TOURNAMENT SCORE SHEET (TGT)

Tournament Number:

Student	Team	1	2	3	4	5	6	7	8	9	10	11	12	13
SAM	Orioles	1	1	2										
SARAH	Cougars	1	2	2										
TYRONE	Whiz Kids	(1)	(1)	1										
MARIA	Geniuses	(2)	1	1										
LIZ	Orioles	2	(2)	1										
JOHN T.	Cougars	2	(3)	2										
SYLVIA	Whiz Kids	3	3	4										
TOM	Geniuses	(3)	2	3										
JOHN F.	Orioles	3	4	5										
TANYA	Whiz Kids	4	(4)	3										
CARLA	Orioles	(4)	3	3										
KIM	Cougars	4	5	5										
CARLOS	Geniuses	4	4	4										
SHIRLEY	Whiz Kids	5	5	5										
RALPH	Cougars	(5)	4	4										
RUTH	Geniuses	5	(5)	4										

Results of Most Recent Tournament | Tournament Table Assignment for Next Tournament

'(From: Using Student Team Learning by Robert Slavin, The Johns Hopkins University Press, 1978, p. 18)

APPENDIX L

TEAM SUMMARY SHEET SAMPLE AND SCORE SHEET SAMPLE

Figure 4. Sample Game Score Sheet

Table # _____

Game Score Sheet

Round # 5

Player	Team	Game 1	Game 2	Game 3	Day's Total	Tournament Points
ERIC	GIANTS	5	7		12	2
LISA A	GENIUSES	14	10		24	6
DARRYL	D.B	11	12		23	4

Figure 5. Calculating Tournament Points

FOR A FOUR-PLAYER GAME

Player	No Ties	Tie For Top	Tie For Middle	Tie For Low	3-Way Tie For Top	3-Way Tie For Low	4-Way Tie	Tie For Low and High
Top Scorer	6 points	5	6	6	5	6	4	5
High Middle Scorer	4 points	5	4	4	5	3	4	5
Low Middle Scorer	3 points	3	4	3	5	3	4	3
Low Scorer	2 points	2	2	3	2	3	4	3

FOR A THREE-PLAYER GAME

Player	No Ties	Tie For Top Score	Tie For Low Score	3-Way Tie
Top Scorer	6 points	5	6	4
Middle Scorer	4 points	5	3	4
Low Scorer	2 points	2	3	4

FOR A TWO-PLAYER GAME

Player	No Ties	Tied
Top Scorer	6 points	4
Low Scorer	2 points	4

Figure 6. Sample Team Summary Sheet

Team Name GENIUSES

Team Members	1	2	3	4	5	6	7	8	9	10
MARK	6	2	2	4						
KEVIN	4	4	2	6						
LISA A.	5	2	4	6						
JOHN E.	6	6	2	4						
DEWANDA	4	4	6	2						
Total Team Score	25	18	16	22						
Transformed Team Score	20	14	13	18						
Team Standing This Week	1	3	5	3						
Cumulative Score	20	34	47	65						
Cumulative Standing	1	1	2	2						

(From: Using Student Team Learning by Robert Slavin, The Johns Hopkins University Press, 1978, p. 16)

APPENDIX M

SAMPLE NEWSLETTER

The Biological Observer

FLASH! The Thinkers and Melior populi tie for 1st place!

The Thinkers and Melior populi were hot on each other's heels with 19 points each last Thursday. Katherine W. and Vickie each brought 6 points to the team score of the Thinkers. Bev and Sharon Decker contributed 6 points each to their team.

In 2nd place was Sucio Cuatro with 18 points. Sarah and Robin were high scorers for their team.

The Organisms were 3rd with 17 points.

THIS WEEK'S SCORES

1st-Thinkers		+ Melior populi		2nd Sucio Cuatro		3rd Organisms	
Karen J	6	Susan	2	Tray	4	Sydney	4
Belinda	2	Bev	6	Sarah	6	Jodi	3
Katherine	6	Barry	Absent	Kelly	2	Mike	6
Vickie	6	Sharon	6	Robin	6	Chara	4
Lisa	4						
	24		14		18		17
Transform	19	Transform	19				

Fabulous 4		Knights	
Pat N	2	Ted P	3
Nancy E	4	Lisa F	3
Susan M	2	Jennifer	2
Bob R	absent	Virginia	2
	8		10
Transform	11		

SEASON STANDING - Cumulative Scores

Thinkers	39	Organisms	33
Melior populi	38	Knights	21
Sucio Cuatro	36	Fabulous 4	20

(From: Using Student Team Learning by Robert Slavin, The Johns Hopkins University Press, 1978, p. 19)

APPENDIX N

RESULTS OF 1980-81 PILOT STUDY OF TGT

PILOT STUDY

August, 1980 - May, 1981

A Comparison of Teams-Games-Tournaments (TGT) and Traditional Classroom Methods in High School Biology

by

Rebecca Ross Dechow

BRIEF BACKGROUND:

From 1970-1976, The Center for Social Organization of Schools at Johns Hopkins University in Baltimore, Maryland conducted ten studies of the effects of teams-games-tournaments (TGT) versus alternative methods of instruction on cognitive academic achievement, student attitudes towards school, peer-interaction and mutual concern. The ten studies were fully funded by the National Institute of Education (DHEW), Washington, D.C., and were conducted under the direction of Dr. David L. DeVries and Dr. Robert E. Slavin. (See HEW contract NE-C-00-3-0114 and Teams-Games-Tournaments: A Final Report on the Research. Report No. 217). Results in seven of the studies showed significant differences in favor of the game treatment for cognitive achievement. The team-games were found to improve attitudes towards school in three out of eight studies set up to measure attitudes. There was greater peer-interaction and mutual concern shown by students in five out of seven studies investigated.

None of the ten studies was in the field of science and only one was conducted in high school. The high school class in social studies showed a significant difference in cognitive achievement at the .1 level. Two other investigations in junior high social studies found no significant differences in cognitive achievement between experimental and control groups. Academically, TGT was found to be most successful in cut and dried subject areas such as math, language arts,

and reading vocabulary in elementary and junior high classes. Yet plans are underway to use TGT in junior high science and possibly even in high school classes.

QUESTIONS RAISED:

1. Could the playing of TGT result in greater academic achievement in a high school science course such as biology than when using traditional classroom methods?

2. Could the playing of TGT bring about positive attitudinal changes toward a science subject?

3. Do students like or enjoy TGT as a means of covering biology chapter material better than traditional classroom methods?

4. Could TGT have an influence an influence on retention of knowledge over a period of time?

Having used games in my own classes in the past and having talked with Dr. Slavin at Johns Hopkins about new projects funded by the National Science Foundation to create TGT materials for junior high life science classes and their desire to possibly also create TGT materials for high school, and believing the above questions merited further study, the pilot study was initiated.

METHODOLOGY:

The pilot study encompassed approximately 200 tenth grade students in eight intact BSCS Green Version Biology classes at Cave Spring High School in Roanoke, Virginia. These students were grouped as general-ability students.

All classes of each teacher were given a 50 item pre-test on the chapters used in the study. Classes of each teacher with similar means from this test were matched and then designated as control or experimental classes. Teacher A and B each had a control class in the morning and in the afternoon, and each teacher had an experimental class in the morning and in the afternoon.

The experimental treatment period consisted of seven weeks during which both experimental and control groups studied chapters 12, 13, and 14 on cell biochemistry, plant physiology, and the functioning animal from the BSCS text.

Teacher A and B were instructed to assign students in experimental and control classes normal textbook readings. All classes engaged in preparations for labs, labs, audiovisuals, discussions, lectures, completing of worksheets, etc. The major difference came in that once a week teams-games-tournaments (TGT) was used in the experimental classes for a class period, while traditional discussion and question-answer methods were used in control classes.

Worksheets for each chapter were carefully made and given to all students in both experimental and control groups. These same

worksheets were then used in the playing of the teams-games-tournaments.

The TGT gaming technique devised by Johns Hopkins was put into effect in the experimental classes. Students were assigned to 3, 4, or 5 member teams. Each team generally consisted of one high-ability student, two middle- or average-ability students, and one low-ability student. This information as to ability was obtained by the investigator from the student files and was based on SRA scores, previous reading ability grouping, and 9th-grade grades. Each student completed his worksheets, read the chapter and prepared for the team game. During competition high-ability students from each different team came together and competed against each other, middle-ability competed against middle-ability from other teams, and low competed against low. When students competed at a table the dittoed sheet of questions and the sheet containing the correct answers would lie face down.

A student first drew a number from a stack of cards and then answered the question for that number on the ditto sheet. Other students at the table who disagreed with the answer given could challenge the answer and give what they thought to be the correct answer. The answer sheet was then checked for the correct answer. At the end of the game, points were tallied for each player based on the number of questions correctly answered and these points were recorded on team summary sheets. The team summary sheets were carefully gone over by this investigator and total team scores

determined. A class newsletter was written, duplicated, and given back to the experimental classes to show standings of the teams and recent scores. Students could be bumped to higher- or lower-ability tables for the following week's competition based on their individual score each week. A bulletin board was also put up to publicize team standings and generate enthusiasm.

At the end of the seven week period, a 60-item post-test was given on chapters 12, 13, and 14 to measure cognitive knowledge. This test and the pre-test for cognitive knowledge were prepared using questions from the BSCS test booklet prepared by testing experts for the BSCS curriculum studies. The reliability for the pre-test was .69 and the reliability for the chapters post-test was .65 as determined by use of KR-20 tests on VPI computers. The chapters post-test was administered again after a ten-week delay from the conclusion of the experiment to measure retention of knowledge.

An attitude test towards biology was administered prior to the beginning of the seven-week experimental period in both control and experimental classes. It was administered again at the conclusion of the seven-week period. This attitude test was created by James Russell and Steve Hollander of Purdue University and was found to have a reliability of .90. The test consists of 14 Likert-type scale questions. The Russell and Hollander test was then used as a model to develop the questionnaire on team games. The questionnaire on team games was administered to the experimental classes at the end of the seven-week treatment period.

For statistical analysis of the data, the prepared program "Statistical Package for the Social Sciences (SPSS)" was used and an analysis of variance computed between experimental and control groups for: (1) the pre-test cognitive knowledge means, (2) the chapters 12, 13, and 14 post-test means, (3) the delayed post-test means, (4) the biology attitude pre-test means, (5) the biology attitude test means following the 7 week experiment, (6) the chapters post-test means and (7) delayed post-test means for low achievers only.

The pre-test scores and student IQ scores were held to be used as covariates to control for possible differences in pretreatment funds of knowledge held by students and in intellectual abilities.

FINDINGS:

As shown in Table 1, there were no significant differences between control and experimental groups on the pre-test measure of cognitive achievement.

Table 1
Pre-Test of Cognitive Knowledge: Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	1	0.40	0.40	0.01	0.911
Within Groups	207	6675.51	32.25		
TOTAL	208	6675.91			

Jan., 1981

Mean for Experimental Group = 19.97
Mean for Control Group = 19.88

Analysis of variance of experimental and control group data, shown in Table 2, for the chapters 12, 13, and 14 post-test which was administered at the end of the seven-week treatment period again showed no significant difference between the groups.

Table 2
Chapters Post-Test of Cognitive Knowledge: Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	P
Between Groups	1	17.93	17.93	0.53	0.47
Within Groups	203	6795.04	33.47		
TOTAL	204	6812.97			

March, 1981

Mean for Experimental Group = 35.94
Mean for Control Group = 35.35

Ten weeks following the chapters post-test, I administered it again as a delayed-interval measure of cognitive retention. Scores of the analysis of variance for that administration of the test appear in Table 3.

Table 3
Delayed Post-Test: Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	P
Between Groups	1	29.15	29.15	0.48	0.49
Within Groups	193	11800.88	61.14		
TOTAL	194	11830.02			

May, 1981

Mean for Experimental Group = 32.77
Mean for Control Group = 32.00

Again, there was no significant difference between the experimental and control groups for the delayed post-test to measure retention of knowledge.

To measure attitudes towards biology, a pre-test was given before the treatment began. Analysis of variance for this data revealed no significant differences between experimental and control groups in their attitudes towards biology as shown in Table 4.

Table 4
Pre-test of Attitudes Towards Biology: Analysis of Variance

Source	D.F.	Sums of Squares	Mean Squares	F Ratio	P
Between Groups	1	0.00	0.00	0.01	0.94
Within Groups	205	111.06	0.54		
TOTAL	206	111.06			

Jan., 1981

Mean for Experimental Group = 2.70
Mean for Control Group = 2.70
(Negative statements were recoded)

At the end of the seven-week treatment period of playing team games, the biology attitude questionnaire was readministered, but the team games or TGT was found not to have caused a significant difference in attitudes between the groups. These results are shown in Table 5.

Table 5
Post-Test of Attitudes Towards Biology: Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	P
Between Groups	1	0.39	0.39	0.64	0.42
Within Groups	203	122.84	0.61		
TOTAL	204	123.23			

March, 1981

Mean of Experimental Group = 2.68
Mean of Control Group = 2.60

Consideration was then given to the proposition that low achievers might perhaps benefit more from TGT and show a significant difference in achievement. This was not found to be the case as shown in Table 6 for the chapters post-test given after the seven-week treatment period.

Table 6
Chapters Post-Test For Low Achievers: Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	P
Between Groups	1	4.04	4.04	0.14	0.71
Within Groups	20	571.23	28.56		
TOTAL	21	575.27			

March, 1981

Mean of Experimental Group = 30.67
Mean of Control Group = 31.54

Table 7 shows results from the delayed interval post-test for low achievers given ten weeks after the treatment period had ended. The mean score for the low achievers in the experimental group was almost the same as it had been in March, while the low achievers in the

control group had a mean score which had begun to drop, but not enough to make a significant difference at the .05 level.

Table 7
Delayed Post-Test for Low Achievers: Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	P
Between Groups	1	26.14	26.14	0.85	0.37
Within Groups	18	554.41	30.80		
TOTAL	19	580.55			

May, 1981

Mean for Experimental Group = 30.25
Mean for Control Group = 27.92

No analysis of covariance statistics were computed in this pilot study.

PITFALLS OF THE PILOT:

This pilot study was carried out according to the TGT booklet published by John Hopkins. However, in our TGT team set-up there was no time during the week for the team to get together and practice for a class period before the playing of the game. Students did work together some on the worksheets, but there was no "team drill." Each student involved in TGT games had to study on their own.

The three page vita has been removed from the scanned document. Page 1 of 3

The three page vita has been removed from the scanned document. Page 2 of 3

The three page vita has been removed from the scanned document. Page 3 of 3