HUMAN ANATOMY INSTRUCTION INVOLVING A PEER ASSISTED LEARNING DESIGN AND COMPUTER TUTORIAL INTERACTION

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By

Robert Joseph Hilbert

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ABSTRACT

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By

Robert Joseph Hilbert

Both peer teaching and learning sessions and computer managed drill and practice sessions appear to be effective instructional strategies; not as a replacement for the classroom teacher but rather as supplementary and complimentary to the traditional format.

In order to evaluate the effectiveness of instruction augmented with computer interaction and peer assisted learning, one hundred and eight community college students enrolled in Human Anatomy, Physiology and Medical Terminology at Delta College, University Center, Michigan, were randomly assorted into a six-group Solomon research design. The first and second groups were pre-tested for their prerequisite knowledge of osteology. The testing instrument consisted of 20 questions requiring a written response to test items representative of behaviors expected for this instructional unit. This particular testing format was employed so that spelling could also be evaluated. Groups Two and Four received traditional instruction, based on lecture-recitation and laboratory

demonstration. Groups One and Three attended the group anatomy lecture but the usual laboratory experience was replaced with the experimental protocol of Peer Assisted Learning and Computer-Assisted Drill and Practice. Experimental Group Five received only the Peer Assisted Learning (PAL) sessions as lecture supplements. Experimental Group Six received only the Computer Augmented Instructional (CAI) supplements. All groups received the same post-test having the same format as the pre-test, but containing different test items.

Students comprising the experimental group were required to schedule at least an hour of computer assisted drill and practice each week. The Peer Assisted Learning sessions for this group required the student to study and learn anatomy concepts and 'teach' them to classmates individually and in small groups. Students alternately had the opportunity to teach and be taught.

Random assortment of experimental groups was approved by analysis of pre-test scores for separate groups. Analysis of student biographical data further confirmed group equivalency.

By paralleling the common pre-test, post-test, control design with experimental and control groups lacking the pretest, both the main effects of testing and the interaction of testing and the experimental protocol were determinable. In this way, not only is generalizability increased, but in addition, the effects of the experimental protocol were replicated in four different ways with these results:

1. All post-test scores were significantly greater than pre-test scores.

2. Post-test scores for experimental groups were significantly greater than post-test scores for control groups.

3. Post-test scores for pre-tested group were not significantly greater than group not pre-tested.

4. Post-test scores for experimental groups not pre-tested were significantly greater than pre-test scores of equivalent groups.

Significantly greater achievement was demonstrated in groups receiving the PAL and CAI augmented instruction. There was no evidence of a pre-testing influence. Ancillary inquiries showed spelling errors to be less and study time reduced for students receiving the PAL and CAI protocol. Both control and treatment groups showed reduced retention after six months. In addition, post-test achievement was found to be greater for groups receiving the combined PAL and CAI instructional supplements, as compared with independent administration. Student attitudes for the experimental protocol were conservative but favorable. Most students were receptive to an instructional strategy that allowed them active participation.

Dedicated

to

Dr. Pamela K. Hilbert, DDS

my wife

'PAMI'

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TABLE OF CONTENTS

Chapter		Page

Chapter Page

CHAPTER ONE

INTRODUCTION AND HISTORICAL PERSPECTIVES

The Problem

Large, mixed ability, classes are typically seen in the colleges of today, especially at the undergraduate level. The typical community college has an admission policy of complete "open-door" to all individuals having a high school, or equivalent, education. Such a policy results in a broad range of abilities among students and a definite challenge to the educational process. As a result, many students are forced into a non-participation role in the classroom and often experience the college or university as an alienating environment. This problem becomes acute as higher education becomes even more available to larger numbers. The ineffectiveness and impersonal character of the large lecture classes conditions students as passive observers in the educational process. The lecture system, for instance, assumes that all students have the same capability and can learn at the same rate of speed. Grading often depends on whether the student understood the material at the rate it was given. The lecture system has other drawbacks. In some ways it is too unstructured. Some lecturers follow a text or outline, but many discuss whatever comes to mind at a particular time of day. In other ways the lecture system is too structured.

Students are required to be in a certain place at a specific time to hear the lecture. Exams for courses are usually scheduled within a short period of time and few exceptions are made for any outside problems or commitments (financial, social, personal) a student may have.

There is always change going on in teaching, whether we arrive at anything new is another question, but there is change. Most teachers, in fact, are constantly "trying harder" to spice up their lectures, to prepare better tests, to make discussions more worthwhile, and to spend more time talking with students as individuals. These innumberable trial and error efforts are essential to good teaching, but they are difficult to describe and to evaluate.

Many of the educational problems of the 1960's persist. Many instructional strategies of the 1970's could well be criticized for apparent aimlessness, and of being deadening, formalistic, mechanical, passive, and rote.

Modern learning systems, which make use of tape, slide film loop, closed-circuit television, programmed, and mastery models, in many ways fail to meet the educational challenges of (a) providing individualized instruction, (b) increasing motivation, (c) scheduling enrichment opportunities, and (d) encouraging self-realization. So, until educational research confirms the merits of an alternate approach, we practitioners continue with the "tried and true" lecture, practical and tutorial methodology.

Related Learning Theory

Experiments in developmental and educational psychology have shown that more efficient methods of teaching can be devised.

When B. F. Skinner published his treatise on behavior analysis, outcries reverberated through all segments of society. Psychologists, psychoanalysts, poets, preachers, and politicians charged that in Beyond Freedom and Dignity Skinner (1971) had equated people with pigeons and rejected those qualities that set humans apart from animals. But the humanists weren't the only ones out to crucify Skinner. Some doubting Thomases among the behaviorists denied their master's philosophy while continuing to practice his techniques. One reason they and a host of pragmatic practitioners continue to operate in the Skinnerian mold is the immediate positive reinforcement it provides. In other words, the scientific model of behavior modification works. It produces the desired effects rapidly and efficiently. So, regardless of philosophical implications, behavior technology is being used increasingly on a variety of levels in a variety of areas.

Teachers have been meting out combinations of reward and punishment to students for hundreds of years and they will continue to do so, with or without formal knowledge of the principles of reinforcement and their relation to learning. The Skinner and Gagne concepts of reinforcement have been a central theme in the historical development of several theories of learning and their applications to education, but psychology did not discover this phenomenon nor

invent the term. Its effects can be seen wherever people learn and change their ways of doing things. Understanding the theory of reinforcement is worthwhile in its own right as well as for guiding the teacher as he adapts and reshapes its principles to fit the special conditions of his course.

The importance of reinforcement for college teaching should not be prejudged by textbook conceptions of salivating dogs, bar-pressing rats, and eye-blinking humans. These are laboratory arrangements used to determine precise conditions and to test hypothesis derived from theory. Reinforcement is the behavioral counterpart of "feedback" in a cybernetic system and in essence it means that a given response is strengthened (or weakened) by the consequences of having made that response. Teachers implement the effects of reinforcement nearly every time they meet with students or evaluate their tests, papers, and reports. The contingencies of reinforcement (the dependent consequences of particular responses) can be positive or negative; as blunt as a kick on the shins or as subtle as a vocal inflection, or a word <u>not</u> used.

The short and intensive history of programmed instruction illustrates an over-simple, over-managed and over-controlled use of reinforcement. Demonstrating that one knows the right answer to someone else's questions is less rewarding to college students than pursuing a personal line of inquiry. As a consequence, the technology of programmed learning has not been widely used in higher education and the teaching machine rather quickly ran its course as a relatively trivial page-turning device. The alogorithmic chaining of questions and answers gave "feedback" to students that they didn't really need and constrained the otherwise powerful effects of the reinforcement principle. But the concept of programming as a <u>model</u> for organizing a course toward explicit objectives, has become a significant force on the college campus.

These developments have mushroomed during the past three years under various labels, although the common feature is best represented by the heading: self-paced supervised study. Several specific applications of the programming (or reinforcement) model would include: mastery learning, modular units, precision teaching, contingency contracting, contingency management, and the Keller Plan.

The influence of Keller's research and instructional design has been extensive. Its success was particularly inspirational for my continued research with peer and computer augmented instruction. Because of this influence, the Keller Plan should be further detailed. Many features of the Keller Plan are incorporated into the research design of this thesis.

In a 1967 address Professor Fred Keller (1967), a distinguished investigator of basic processes of learning, described to fellow educators a method of college teaching which breaks radically with past practices. In the eight years since Keller's address, the method--sometimes known as "self-paced supervised study" but often called simply the Keller Plan--has been applied in numerous college courses around the country.

The work of a course taught by the Keller Plan is divided into units. In a simple case, 15 units may be delineated which reflect the 15 chapters of the course text. A student starting the first unit is given a printed study guide that introduces the unit, describes its objectives, recommends procedures for studying to achieve these objectives, and includes sample questions. The student works individually on the unit, and must demonstrate his mastery of the material before moving on to the next unit in the sequence.

Mastery is ordinarily demonstrated by perfect or near perfect performance on a short-essay examination (Keller's preference for his introductory psychology course). The student may take an examination on a given unit whenever he feels ready, and failure to pass the test on the first try, the second, the third, or even later, is not held against him. However, he is given the study guide for the next unit only after he demonstrates mastery of the unit. Thus, students move at their own pace through a course from start to finish. A student may meet all course requirements in less than a semester, or he may not complete the course within the semester.

Throughout much of the course, the classroom simply functions as a study hall, where the student may read course material. Lectures and demonstrations are given less frequently than in a conventional course (perhaps six lectures in the course of a semester). In Keller's courses lectures and demonstrations were vehicles for motivation; they were not compulsory and no examination was based on them.

Keller (1968) summarizes those features of the plan that seem to distinguish it most clearly from conventional teaching procedures.

> "(1) The go-at-your-own-pace feature, which permits a student to move through the course at a speed commensurate with his ability and other demands on his time.
>
> "(2) The unit-perfection requirement for advance, which lets the student go ahead to new material only after demonstrating mastery of that which preceded.
>
> "(3) The use of lectures and demonstrations as vehicles of motivation, rather than sources of critical information.
>
> "(4) The related stress upon the written work in teacher-student communication; and finally,
>
> "(5) The use of proctors, which permits repeated testing, immediate scoring, almost unavoidable tutoring, and a marked enhancement of the educational process."

It has been estimated that over 500 faculty members in a variety of disciplines have taught (or are about to teach) Keller-based courses. Not all the courses include all five of the features described by Keller; modifications have been introduced to fit a variety of local demands. A review by Kulik (1973) of early reports on application of Keller-based plans made the following points:

1. Students taking Keller courses report spending a good deal of time on their studies. Several investigators report relatively high dropout rates from Keller-based courses, and the most frequent comment from students who withdraw is that these courses are "too much work."
2. Students finishing Keller-based courses usually are given high grades. Since grades are assigned in a manner having little parallel in traditional courses, grade distributions do not necessarily indicate that students learn more, but there are no reports of poorer learning under the Keller Plan.

3. In a number of comparisons, there are no significant differences on final examination performances of students in Keller and conventional classrooms and in a few investigations, students studying under the Keller Plan do somewhat better on final examinations. Interpretation of these results must take into account dropout rates.

4. Most studies show that students completing Keller courses are highly satisfied with the learning method. In the University of Florida project, for instance, all students reported that they preferred the unit-performance format to typical course formats. Evidence showing strong student dissatisfaction with the Plan has not yet been presented. Interpretation of these results also must take into account dropout rates and grading practices.

5. There is some consensus among those who have used the Keller Plan that undergraduate students serving as proctors benefit especially from the method.

6. Several authors have noted the possible cost-savings to institutions using the Keller Plan. The use of undergraduate assistants is one basis for the economy.

After over a decade of racing to produce more scientists than the Russians, educators are taking a long, second look at science for the citizen, introducing healthy doses of literature and historical perspective into even the most rigorous disciplines and allowing the student to discover science for himself, as the "new humanity." Currently we see a change in educational philosophy from mass education for the masses to relevant, individualized instruction.

At the same time, a "Fourth Revolution" is taking place throughout the educational world, with sophisticated electronics beginning to assist the teacher in providing information, guidance and the inevitable testing to students.

Armed with new discoveries in educational psychology and the experience gained in 10 years' experimentation under abundant government funding, academic innovators are eager to apply this Fourth Revolution to science education. But they are already being challenged by declining financial support, decreasing science enrollment and competition from private industry.

It is not surprising that great interest in learning should arise at the present time. The current movement toward educational reform has been closely related to a number of highly significant educational trends: decentralizing of teaching, differentiated staffing, the individualization of instruction, the self-help and the human potential movements, the need for more teaching resources, the growing criticism of competitiveness in the schools and the demand for more cooperative learning situations, the use of the consumer of the service as a service giver, the demand for accountability in the schools and the recognition of the schools' waste and inefficiency, and the great new emphasis on participatory processes, the recognition that the teacher is not the sole repository of knowledge and the concomitant demystification of the learning process, the increased interest in tutorial methods, and the popularity of such informal learning as educational television.

There is increasing recognition today that learning need not be a win-lose game in which some pupils presumably learn a good deal in a competitive grading system and others do not.

As in most enterprises of man, there is the element of derision. Such is the case with modern learning theory; however, this discord often provokes continued research rather then establishing a destructive schism. The "Discoverist" and "Behaviorist" have carefully constructed cogent arguments for their separate points of view.

The Discoverist's theory of education, for instance, is based in part on the work of the Swiss psychologist Jean Piaget. For the past 40 years Piaget has been investigating intellectual development. Experiments with children have led him to conclude that intelligence develops through various stages, stemming from active interaction with the environment. In the first or sensori-motor stage a child learns basic concepts of the physical world by being exposed to a variety of tangible and visible objects. This and other intermediate stages are necessary, says Piaget, before a child or student can build up to more difficult, abstract modes of thinking.

In a traditional chemistry course, for instance, students memorize formulas and perform classic experiments that confirm foregone conclusions. According to Piaget this can be damaging to lively minds. Instead, his theory says, students should learn the basic principles of chemistry by being allowed to develop their own experimental projects. Discovery through doing, says Piaget, not only teaches but can awaken original thinking (Wadsworth, 1971).

At the same time this discoverist approach was being developed and expanded, a behaviorist or stimulus-response approach to education was gaining acceptance among educators.

The Harvard psychologist B. F. Skinner has been an influential theorist for this school of thought. Experimenting with animals instead of humans, Skinner (1968) developed a method of teaching that is much more structured and controlled than that of Piaget.

Upon operant conditioning or rewarding desired responses, Skinner has been able to teach pigeons to play Ping-Pong. Because both pigeons and humans are organisms, Skinner pontulated that operant conditioning and a mechanical treatment of stimuli and responses could be used in the classroom. The desired response being a correct answer and rewarding reinforcement being approval from the teacher or, in the case of a teaching machine, permission to go on to the next problem. In a chemistry course hundreds of formulas and reactions can be learned in this way. By designing precise contingencies, Skinner suggests that very subtle discriminations can be taught. Discoverists would say such learning is merely mechanical mastery of skills and leaves no room for original or insightful thought. Behaviorists would answer that insight is nothing more than the proper use of previously conditioned responses.

The discoverist and behaviorist approaches are not diametrically opposed and they are not mutually exclusive. But putting either of them into operation requires trained teachers, special texts and specially designed equipment and environments. The discoverist teacher needs texts that are based on Piaget's stages of development, a variety of stimulating objects and equipment and an open type of classroom.

The behaviorist teacher, on the other hand, needs a whole different set of texts (programmed instruction sets and even teaching machines) and a highly structured environment.

One teacher or group of teachers might decide on a particular teaching methodology only to find that the materials are not available. Even when the materials are available, a student might move from one teacher and theory in the morning to a completely different approach in the afternoon. A specific theory or approach is necessary if a teacher is to do more than impart information on a hit-or-miss basis, but the superimposition of theories, subtheories and neotheories on older theories leads to a muddled education system. It is this muddle that is at the root of much of the criticism leveled at our present education system.

Personalized System of Instruction

For years teachers have been giving gold stars for good grades or good behavior. But Skinner and behavior technology have taught more than positive reinforcement to teachers. Programmed instruction and teaching machines are the result of more sophisticated uses of behavior modification. One system in particular--based on Skinnerian conditioning and learning theory--is gaining increasing acceptance in universities and colleges. It is known as the personalized system of instruction (PSI), and was designed by Fred S. Keller (1968)

PAL and CAI as Proposals for Change

And who will carry out the innovations of the "Fourth Revolution"? In a 1967 paper, the biologist-educator, Sir Eric Ashby, classified four revolutions in education:

1) Shift of education from parent to teacher.

2) Adoption of the written word.

3) Invention of printing.

4) Introduction of computerized instruction.

According to a report entitled "The Fourth Revolution" by the Carnegie Commission on Higher Education (1972), electronic education will lessen routine for faculties and offer a richer variety of courses and increase the opportunity for independent study by students. But the success of this technology in education will require more talent than money. New technology and curriculum changes can be beneficial, but it is also a matter of GIGO (Garbage in, Garbage out). You put garbage into the computer, and you will get nothing other than garbage out.

The fact that well-conceived CAI (Computer-Assisted Instruction) can and does lead to increases in instructional output has been well publicized. What has received less publicity, however, is the fact that these learning gains are attributable less to the hardware aspects of CAI than they are to the pedagogical wisdom built into the CAI software, the actual programs that control the responses of the computer to the student. The most effective CAI programs always gave students individually tailored remediation, pin-pointing the student's errors for him, and often suggesting an improvement. Such programs also insured that a student would get as much practice as he needed to be able to satisfy the requirements of the lesson. In effect, the CAI student could carry on a continuous instructional dialogue with a highly accurate and proficiency-oriented tutor. That such applications of CAI have been successful comes as no surprise when one contrasts this pedagogical quality of this kind of CAI experience with the experience offered in the typical classroom setting.

Cost and availability factors greatly limit CAI implementation for most colleges. What is needed is an educational strategy that encompasses the merits (e.g. Drill and Practice opportunities) of CAI and could be easily, quickly and economically put to use in the classroom.

I perceive the PAL system as one possible solution.

Peer Assisted Learning.

The essential notion underlying the PAL system is that the critical supervisory functions that are attended to by a machine in CAI can, in principle, be attended to by a trainee in a sort of buddy system. One in which each member plays alternating "teacher" and "student" roles. Not only might the trainee functioning as a student derive all the benefits of the CAI trainee, but so might the trainee functioning as a teacher derive special benefits resulting from his special role in relation to his pal.

Such a system of peer assisting peer, resolves the well known instructional problems of inadequate opportunity for supervised practice that students can actually receive in conventionally structured teacher-mediated learning environments. The PAL system has involvement as its greatest strength. Even in the best intentioned teacher-mediated classrooms, a sustained level of involvement for any

particular student is an impossibility, especially seen in the large university classes. Non-involvement, to whatever extent it exists, inevitably induces the student to 'turn off' or 'tune out.'

Within the PAL system, students working in pairs and within small groups exercise full responsibility for their own instructual progress, each providing pacing and coaching for the other. The "student" proceeds through the required material at his own pace while receiving immediate feedback as to the correctness of his performance and his progress from his "teacher."

When a class is run this way, students can progress as rapidly as they are able and spend extra time on those points most difficult for them. They are not required to wait for the rest of the class before they can proceed, nor are they permitted to leave a topic they are not sure of merely because the majority of their classmates have already moved on.

This system, then, insures individualized instruction; it is the student's own performance, and only his performance, that regulates his progress. Also, because each student must grasp each part of the course before he is allowed to move on, there is no uncertainty about what an individual is supposed to learn.

Finally, there is no uncertainty in the mind of the student as to the correctness of his performance; he is told immediately whether his response is right or wrong, and if he makes a mistake, he is immediately provided with remediational information.

PAL, then, uses the buddy system to implement a course of instruction based on a preselected sequencing of content which insures individualized yet uniform teaching.

The course instructor would assume the role of implementor, facilitator, organizer and trouble-shooter. His lecture material could become less content directed and more conceptual in design. Freed from the preponderance of subject matter usually "lectured out," the instructor is permitted to integrate, synthesize and make relevant the topic under discussion. His lecture would become more idiosyncratic and more efficaciously paced. The lecture would be more pursuant of affective than cognative objectives. Students working together are certainly not very novel to instructors of laboratory sciences where lab partners are required to make maximum use of available equipment, but, the control, organization, and management required of the PAL system is unique and, I might add, essential.

Implicit in the "Learning Cell" strategy developed at McGill University by Goldschmid (1971) and others, is the necessity of student preparation in advance of the dyad encounter. While idealistic in design, pragmatically students are often less than eager or in some cases even unable to prepare themselves prior to class.

The PAL system encourages mutual student learning via a multi-mediated learning strategy, followed by mutual review, practice and evaluation as each assumes the role of "teacher" and "learner."

There is no attempt here to define the PAL system to its finite, but rather to propose an educational strategy. The detail of its implementation will be later hung to this skeletal philosophy. In essence, I chose to examine the following considerations:

1. Will instruction, augmented with peer interaction and computer tutorlage, provide a more successful educational experience in the mixed ability classroom found in the large community college?

2. Is the subject of Human Anatomy particularly suited for an instructional design which encourages peer and computer interaction?

3. Would provisions for student tutorlage outside the classroom stimulate and encourage the lecturer to be less pedantic and detail oriented and more involved with application and relevance of material?

4. Would peer learning promote the development of scientific communication skills?

5. To what extent can the potent influence of peer pressure be used in an instructional design?

6. Can the successful application of peer tutorial programs in public schools be implemented at the college undergraduate level?

7. Can the learners need for drill and practice be successfully administered by the computer?

8. Will students demonstrate greater learning, longer retention, and more satisfaction with a Peer Assisted Learning system over conventional teaching strategies?

9. After the novelty of computer operation has ebbed, will students continue to utilize the computer as an instructional aid?

These considerations are later structured into testable research hypotheses that become the central objective for this investigation.

CHAPTER TWO

LITERATURE REVIEW: COMPUTER-ASSISTED INSTRUCTION

Education, besieged by demands for higher quality and greater quantities of instruction at lower cost, is turning to computer technology for assistance. Success will not be achieved overnight, but computers seem likely to prove as indispensable for education as they have for most other applications. One of these intriguing applications is the potential of computer-assisted instruction for answering today's most pressing problem in education--the individualization of instruction.

Many people who have actually observed and worked with this newly developing technology for aiding education believe the computers are a beneficial force. They see the computer-aided system not as a dehumanizing robot but as a sensitive, multi-purpose tool for presentation of information, expansion of individual minds, and release of teachers from such mundane, repetitious work as practice drill, routine assignments, reviews, scoring, and instructions on homework and tests.

Computer-Assisted Instruction (CAI) has been successfully incorporated into the instructional process of many institutions and in many ways, CAI should no longer be considered a novelty on the educational scene.

Acceptance of computers in the classroom is still a controversial issue for many educators. Some are wary of the uncritical adoption of yet another form of educational technology. Both sophistication and costs are in part rationale for cautious acceptance. Many are concerned about justifying the considerable financial investment involved, particularly now with the call for accountability and the decline in federal funding for education.

The computer has also been accused of being plodding, inflexible, unimaginative, and stifling to the intellect and creative impulses, and some CAI programs are very likely guilty of the charge. However, condemning CAI generally for this offense is comparable to condemning <u>all</u> human teachers for the incompetence of some.

No one denies that a good human teacher can teach better than any machine-oriented program, but how many good teachers exist and what is the proportion of such teachers to students? The ancient system of an individual teacher for each student may be excellent but, of course, impossible today on our crowded planet. In a sense, CAI goes back to this one-to-one system.

CAI cannot only accommodate vast personal differences and abilities--even to providing completely different topics or grade levels of difficulty to different students in a class--it also shields the student's mistakes or "stupid" questions from his classmates. In addition, it must be mentioned that CAI is essentially indifferent to the color, social status, or sex of the student, and unlikely to show

favoritism on these grounds.

If CAI does help to hold the interests of the quicker students (with more interesting and advanced material) and the slower ones (with timely assistance, remediation, etc.), and if teachers are able to provide more personal attention to individual students seeking help or more opportunities, then the benefits to society could be enormous.

Additional apprehension probably results from the loss of confidence that computers brought upon themselves in the mid 1960's. Far more was promised, even for CAI, than was actually delivered. In the late 1960's, private companies assembled and marketed "CAI Systems" for educational purposes. In most cases, the equipment and software that was pressed into service had been designed for business or scientific applications, and they proved to be too slow, unreliable, and expensive for instructional use.

While there are numerous descriptive accounts of computer applications in education, there have been few studies to determine the effectiveness of computer-assisted instruction. Attempts to measure the effectiveness of CAI versus other instructional strategies suffer from the same problem as traditional educational research, namely the use of student achievement of content as the sole criterion of effectiveness. Many subjectively based studies are published, but finding conclusive answers in reported research is more difficult. In many ways, CAI research could still be considered in the developing stage. Computer interaction generally follows along four basic modes; tutorial, problem solving, simulation, and drill and practice.

TUTORIAL

The tutorial mode of computer-assisted instruction is intended to approximate the interaction which would occur between a skilled, patient tutor and an individual pupil. A tutorial system is used to initially present a concept and to develop a student's skill in using the concept. The basic model is the presentation of instructional frames which elicit frequent responses from the student. Each response is then evaluated and appropriate new instructional material is presented on the basis of the pupil's responses. Much of the CAI tutorial material is similar to printed programmed instructional material.

A number of research studies have shown that CAI tutorial programs are at least as effective as traditional instructional modes in teaching several subject areas.

An early study reported by Atkinson (1968a) concerned the first year of operation of the Stanford CAI Project as conducted at the Brentwood School in East Palo Alto, California. Visual display terminals were used in the teaching of initial reading skills to first graders. A control group received traditional classroom instruction in reading, but were exposed to CAI for mathematics instruction. In terms of achievement the group receiving CAI reading instruction performed significantly better on the California Achievement Test and on a test developed by the Project.

In addition to better overall achievement for the CAI group, it was found that boys and girls progressed through the CAI materials at a comparable rate. This is contrary to the long accepted assumption that girls acquire initial reading skills at a faster rate then boys. A comparison of cumulative rates of progress for fastest, medium, and slowest students showed consistency over time, also suggesting the capability of CAI to accommodate individual differences.

Similar results were reported by Fletcher and Atkinson (1972a) in a later evaluation of the Stanford CAI reading program. Teletypewriter terminals with audio headsets were used for daily eight-to-ten minute sessions of computer-assisted instruction in initial reading. For comparative purposes, the study used 50 matched pairs of first graders, selected on the basis of performance on the Metropolitan Readiness Test and drawn from classrooms having teachers of comparable ability.

One student in each pair was taught via the CAI program, while the other student received no CAI instruction in reading. Achievement results of the CAI group were compared with those for the group taught in traditional fashion. After one year of instruction, the CAI students made significantly greater gains in average reading grade placement as measured by post-test performance.

Again, CAI was found to positvely affect the reading progress of boys compared to girls. Cross-sex comparisons in this study seem to cooroborate the earlier finding reported by Atkinson (1968b) that boys in CAI reading perform about as well as girls, suggesting a greater rate of progress for boys due to CAI.

Morgan and Richardson (1972), in describing the Montgomery County Public Schools (Maryland) Project REFLECT, reported significantly higher gain scores on standardized tests for students using tutorial CAI. The pupils were in a remediation program for Algebra II. All students were taught by the same teachers but those who had access to CAI programs made the higher scores. The total instruction time for both groups was equal.

In comparing CAI tutorial and the conventional lecture mode of instruction in teaching the basic elements of tests and measurements to prospective teachers, Lorber (1970) found the mean post-test score of the CAI group to be significantly higher. The study, conducted at Ohio University, involved students enrolled in a test and measurement course. The experimental group received course instruction via CAI while the control group attended regular lectures. The Measurement Competency Test was administered to both groups at the conclusivion of the course. In addition to achieving a higher mean score on the test, it was found that the experimental group had spent less time in instruction than had the control group. The CAI group also indicated a desire to have further contact with CAI both as users and as authors.

Cropley and Gross (1973) found no differences in achievement of students who learned the FORTRAN computer programming language through tutorial CAI, traditional, and programmed instructional methods.

Even when tutorial CAI does not result in more effective learning, efficiency is often achieved in terms of instruction time.

Proctor (1968), in comparing CAI with a lecture-discussion strategy for the presentation of general curriculum concepts at Florida State, found that the only difference between the groups was in the amount of instructional time required, which was less for the CAI group. There was no difference between the groups on achievement or retention.

In a study designed to assess the effect of CAI on attitudes toward CAI and mathematics, Kockler (1973) found similar results. At the end of the study, the 64 college-level students displayed no differences in attitude but the CAI group spent less time in instruction.

The compression of time seems also to hold true for adults as demonstrated by Krupp (1972). The Honeywell plant in Walthem, Mass. needed to teach employees general concepts of higher level computer languages and develop their skills in programming in APL. Since the objectives were criterior referenced, no difference was expected between the achievement levels of the CAI and lecture groups; the CAI group, however, spent an average of seven hours learning, with a range of 5-10 hours, while the lecture group spent 24-30 hours covering the same material.

Fletcher and Suppes (1972b) in a study of Computer Curriculum Corporation reading program for grades four through six, found that the CAI program presented about twice as many new words as were presented in the comparable classroom text program. The increased amount of material presented was found to prevail even though students used the teletypewriter terminals for brief sessions of ten minutes.

Alpert and Bitzer (1970) report on experiments aimed at evaluating the effectiveness of a medical science course run on the PLATO system at the University of Illinois. Although the statistics are not given, the researchers claim that those students taught with the PLATO system scored as well in grade performance on a nationally administered test as did a control group. The significant fact was that the experimental group required only one-third to one-half as many student-contact hours of instruction as compared to conventional classes. Further, measurements made over a 26-week period showed the PLATO group to have greater retention than the control group. Alpert and Bitzer come to the following conclusions based on these results:

1. The interactive nature of the system maintains student interest and involvement.
2. The student has considerable choice of alternative teaching strategies and can proceed at his own pace.
3. The program is response-sensitive, which means that lessons can be modified according to the student's performance.

Kromhout, Edwards, and Schwarz (1969) report on two studies conducted at Florida State University:

1. CAI review lessons were given to student volunteers. Slightly more than one-third of the class

in freshman physics volunteered for this review. Their exam grades on four hourly exams averaged 10 percent higher than those who did not use the review. The authors mention that a selectivity factor might have been present and that students who volunteered for the review might have been more interested or motivated than the average student. This criticism, in my opinion, is important enough to make the validity of the entire study questionable.

2. An entire introductory physics course was taught in two ways. One used lectures, PSSC movies, and graduate assistants for consultations; the other substituted a self-paced CAI program for the lectures and personnel at the CAI center for consultations. There were so many volunteers for the experiment that selectivity was not a problem. (A random sample was taken from the larger number of volunteers.) Results, which are displayed graphically, seem to show that the students in the self-paced CAI group perform better than the students who receive group lectures. However, no statistics are given and some important criticisms can be made of the study. The researchers credit the increased involvement of the students with CAI in producing the increase in grade points. It is also possible that the self-paced nature of the course

was responsible for the increase or that proctors in the CAI center provided better counseling than the graduate assistants.

PROBLEM-SOLVING

In the problem-solving mode the student develops his own computer program for solution of a problem or a class of programs. In analyzing it for computer solution, the student, it is claimed, gains a deeper understanding of the problem and the algorithm for its solution. Tedious and repetitious calculations are taken over by the computer, freeing the student to focus on structure and relationships and to research for patterns.

The most common subject area for use of the computer for problem solving has been mathematics, and the research that has been done in this mode has been in the field of mathematics, from grade seven through college.

In the Computer-Assisted Mathematics Project at the University High School, University of Minnesota, the BASIC programming language was taught to students in grades seven, nine, and eleven. All students except low achievers learned the language with no difficulty. In this program, however, Johnson (1966) found no significant differences in achievement between the students who had continued their regular mathematics curriculum and those who had, in addition, written programs in BASIC. The results were similar for grades seven, nine, and eleven.

The opposite effect was found in a study by Bitter (1970). Five Colorado colleges and universities participated with interested instructors teaching a computer-extended introductory college calculus class. Students in the computer-extended classes learned BASIC on their own (with a programmed text) and solved homework assignments by writing and running computer programs. Each instructor also taught a control class which covered the same content but without the computer. The students who were provided with computer-extended instruction achieved significantly higher than did those in the traditional classes.

Interestingly, all of these studies report a high degree of interest and motivation on the part of students participating in use of the computer, and little difficulty in learning to program in BASIC, even for seventh graders.

Simulation

In this mode of computer use, students interact with a computer-based model of reality. The model may represent an economic system, a social system, or a set of physical relationships. In using the simulation students learn the structure of the system, the relationships and assumptions operating, and they have an opportunity to test and refine decision strategies. Often, a science experiment can be simulated on the computer when it is too costly, difficult, dangerous, or time consuming to perform in the school laboratory.

Computer-based simulations have been developed in virtually all of the sciences, including social science. It is in those

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those areas that research has been reported on the effectiveness of simulations in instruction.

Culp and Castleberry (1971) report on two studies at the University of Texas in undergraduate organic chemistry classes. In one, an experimental group was given access to computer simulations in addition to the regular lectures and laboratory exercises. The semester test average for those students who used the computer was significantly higher than those who did not use it. In the second study, one group used supplementary computer simulations, one had supplementary tutoring from teaching assistants, and a third group had only the usual lectures and laboratory. The results were equivocal - the computer group scored significantly higher than either of the other two groups on only a few of the chemistry subtests.

Another experiment with chemistry laboratory simulation was reported by Hollen, et al (1971). Students interacted with a computer simulation to perform qualitative analysis of unknown substances, for example, a substance in the Silver group. A student could, for instance, direct the computer to add 5 drops of a reagent, heat the substance, filter it, perform a flame test, and so on. The computer reported the result of each action. Some students were shown colored slides of the results, e.g. a test tube with a clear solution and a white precipitate in the bottom. Finally, the student could make a conclusion about the substance, e.g. "lead is present," and was told if he was right or wrong. The results of this study demonstrate that a simulated exercise of this type will produce terminal behaviors equivalent to (or slightly better than) traditional exercise, and at a significant saving in student time. In view of the problems in scheduling equipment and laboratories in overcrowded courses, these findings could offer some viable alternatives.

Lunetta and Blick (1973) conducted an experiment with computer-based simulations of inductive experiments in force and motion with high school physics students. A control group performed the experiments in a traditional laboratory, using PSSC materials. One experimental group used only computer-generated data sheets plus film loops, and a second experimental group used only film loops plus computer simulations. Analysis of the data showed that learning was significantly greater for students using the computer simulations than for either of the other two groups. Furthermore, students in the control group spend 8.3 times as long in instructional unit activities. However, retention was greater for the control group than the simulation group. A favorable attitude toward CAI was reported by both experimental groups.

Drill and Practice

The drill and practice mode of CAI involves the use of the computer to drill students in facts or to assist the student in practicing skills. With drill and practice, facts or skills are previously learned through some other mode or means. The students then use CAI drill and practice programs to memorize those facts or to practice those skills.

This has been a very popular mode of CAI and one in which considerable research has been done, particularly in

elementary arithmetic and language arts.

Arithmetic

Extensive research on the effectiveness of CAI drill and practice in arithmetic was reported by Suppes and Morningstar (1972a). The students in experimental groups received from 5 to 8 minutes a day of CAI drill and practice in addition to normal classroom instruction in arithmetic. The students in the control group received only normal classroom instruction in arithmetic. The arithmetic portion of the Stanford Achievement Test was used both as a pre-test and as a post-test.

About 800 California students in grades 3-6 were included in the experimental (CAI) groups in 1966-67. During that year the students in the experimental groups gained more than the students in the control (traditional) groups at all grade levels. The differences between gains of the experimental and control groups were statistically significant for all grades except the fifth. The largest difference in gains was in grade four.

In general, the low ability students gained relatively more from CAI than did the middle and high ability students.

Martin (1973) reported on a study of the effectiveness of CAI drill and practice conducted by TIES, using the Suppes arithmetic programs. Their sample included 1,448 third and fourth grade students in the Minneapolis area. The sample was divided into two groups, a control group that received traditional arithmetic instruction and an experimental group that received in addition to traditional instruction, from five to seven minutes of CAI drill and practice either every

day or every other day. The results were analyzed by type of instruction, sex, grade level, and ability level. The students who received CAI drill and practice gained more than the students who received traditional instruction only. CAI drill and practice was most effective for boys, fourth graders, and low ability students.

Arnold (1970) and Scrivens (1970) reported the results of CAI drill and practice in Waterford, Michigan. During 1968-69 CAI drill and practice was used in grades three through six. In 1969-70 it was used in grades two through six. In both years gains on standardized arithmetic achievement tests were compared between the CAI students and students receiving traditional instruction. During 1968-69, the CAI students in grades three and four gained more than the non-CAI students, the fifth grade non-CAI students gained more than the CAI students, and the gains were the same for the sixth graders. During 1969-70, however, the gains at all levels, two through six, were greater for the CAI students.

Gipson (1971) measured gains in arithmetic ability of seventh grade remedial students with both a standardized test (WRAT) and a test specially designed to measure the objectives of CAI drill and practice. In that study, the gains as measured by the special test were significant although the gains as measured by the standardized test were not.

Suppes and Morningstar (1969b) evaluated computer-assisted instruction programs in Russian. A computer-based Russian program was tested at Stanford on a class of 30 freshment in the fall of 1967 and on 19 sophomores in the fall of

1968. The 1967 study used two of the four sections as control groups. The CAI group spent about 50 minutes a day, 5 days a week, receiving computer instruction. Seventy-three percent of the students who started the computer course finished, compared to thirty-two percent in the control group. The results show that the computer-based course held the interest of the students significantly better than did the regular course. The study also showed that the computer-based students had lower error rates in all three quarters, but the difference was statistically significant only for the fall term. I would agree with the researcher's opinion that the high mortality rate in the control class biased the experiment against the CAI group.

Summary

The use of computers as educational tools is still extremely limited when one considers their potential for improving the instructional process. Many problems remain to be solved, namely the obvious problems of hardware and costs as well as the deeper problems of understanding the learning process more fully and applying that knowledge in both curriculum development and evaluation.

Rather than being a unique medium of instruction, the computer should more correctly be considered as the core of a system which combines several different media for instructional delivery. Computer-based instruction often makes use of printed display which obviously is not unlike the printed display in texts. The response component of CAI instruction, generally via type, is quite appropriate for information learning.

Most of the techniques employed to date have a weak or non-existent pedagogical base. Undoubtedly, we can look forward to revisions in this area as more soundly based theoretical approaches are developed. In fact, it is the power of the computer that may well lead to the development and confirmation of new theories of learning, through its ability to record and subsequently analyze the reactions of great numbers of students of computer-assisted programs and systems.

When this study was begun, it was anticipated that there would be a wealth of research on the effectiveness of CAI. That is not the case. Although there have been some excellent studies of the effectiveness of CAI, most CAI programs have never been evaluated for effectiveness--at least the results have not been publicly reported.

However, based on the research that has been reported, the following conclusions can be drawn:

1. In general, CAI has proven to be an effective instructional tool as measured by the resulting student achievement. It appears to be more effective in the tutorial and drill and practice modes than in the problem solving and simulation modes.
2. When students are permitted to proceed at their own rate, they will generally learn more rapidly through CAI than through traditional instructional methods.

3. Retention of material learned does not appear to be as high for some CAI as for traditional instruction.
4. As a supplement to normal classroom instruction CAI is as effective as other means of individualized supplemental instruction.
5. CAI, especially in the tutorial and drill and practice modes, is relatively more effective for low ability students than for middle and high ability students.
6. Except for times when equipment malfunctions, both students and teachers are highly enthusiastic toward CAI as a means of instruction.

CHAPTER THREE

LITERATURE REVIEW: PEER ASSISTED LEARNING

It has long been known that students learn from their peers. Teachers have made use of monitors, lab partners, and tutors for as long as formal education has existed. But a more significant observation that has captured the imagination of educators recently is that students learn MORE from teaching other students. In recent peer tutoring research, the focus has shifted from the learner to his tutor. Several studies have shown greater gains in achievement for the tutor than for the learner. The tutors gain through repetition, review, reformulation, and raising the learning task from the knowledge to the application level.

The technique of learners teaching each other can be traced back to the first century, the great Roman teacher, Quintilian, pointed out in his Institutio Oratoria how much the younger children can learn from the older children in the same class. In Didactica Magna, probably completed in 1632 but published first in 1849, the Moravian teacher, John Comenius, wrote:

"He who teaches others, teaches himself is very true, not only because of consistent repetition impresses a fact indelibly on the mind, but because the process of teaching in itself gives a deeper insight into the subject taught . . . The gifted Joachim Fortius used to say that . . . if a student wished to make progress, he should arrange to give lessons daily in the subjects which he was studying, even if he had to hire his pupils."

A few years later the English schoolmaster, John Brinsley, in his book The Grammar Schoole, which appeared in 1612, described his use of "two or foure Seniors in each fourme . . . for overseeing directing, examining, and fitting the rest of the children in every way." Cloward (1967).

This method of helping the teacher was also used with very young children before the eighteenth century. Jean Baptiste de la Salle, who founded the Christian Brothers to educate young children, outlines in his Conduite des Ecoles the monitorial system he used at Theims in the 1680's. The Reverend John Barnard said in his autobiography that it happened to him when he was a five-year-old schoolboy in Massachusetts in 1686. But it was not until the late eighteenth century, when the Industrial Revolution spawned intense public interest in education, that mutual instruction became widely publicized.

In 1791, the Anglican cleric Andrew Bell took charge of a boys' orphanage in Madras, India. Bell found himself unable to influence the adult teachers available to teach his children properly. Having observed the Hindu system of mutual instruction, he turned to his boys for help and discovered that they could be excellent teachers to one another.

Bell recorded his experience in An Experiment in Education, published in 1797, and considered himself the inventor of monitorial instruction. But the man who most vehemently and successfully claimed the "new" idea for his own and who did the most to spread it as a revolution in education was Joseph Lancaster, an English Quaker.

In 1798 Lancaster opened a school for poor children in London. He intended to hire adult assistants to help him teach but could not raise the money. As a result he was forced to see whether the children themselves could help one another. Like Bell, Lancaster was so overwhelmed with the constructive consequences of this invention that in 1803 he wrote a book, Improvements in Education, describing his experiences and devoted the rest of his life to telling the world about the new educational method.

Lancaster lectured passionately on the monitorial system in Britain, the United States, and South America. His personal endeavors were beset by difficulties, since his projects invariably exceeded his resources, but the ideas he spread and the schools he caused to be established were impressively popular for some thirty years.

In the pursuit of economy, Lancaster grossly overmechanized his system. The educational idealists of the day objected and argued that good adult teachers were better than children any time.

These protests were somewhat irrelevant at first since there were hardly any teachers--good or bad. By the mid-nineteenth century, however, the growing supply of teachers and the combined pressures of organized labor, the consciences of the rich, and the ideals of the pure in mind led to the birth of public education and the end of the monitorial system.

Economy is not the essential virtue of mutual instruction and many were not deluded by its tempting economic appeal. William Bentley Fowle (1875) was one of these. Fowle grew up in Boston. His first experiment with the monitorial system dates back to the early 1820's when he found himself with a school for uneducated poor children on his hands and no teacher. Fowle, who was then a printer and bookseller, took the teacher's place temporarily rather than deprive the children of school. But since no other teacher could be found, Fowle ended up serving for several years as schoolmaster to well over a hundred boys and girls of all ages.

Fowle's work was so impressive that in 1827 a group of Bostonians sought him to organize a girls' private school along the same lines. This school of about a hundred pupils he taught on his own from 1827 until 1840.

For anyone who has lived with children the educational benefits of mutual instruction are apparent. Fowle found that it was the rare child who could not teach something to his classmates. Do we have in mutual instruction an obvious and promising way to personalize and individualize instruction?

It is therefore clearly apparent that benefits to both tutor and tutee were recognized and exploited by even the earliest educators. From the monitorial schools of the early nineteenth century came the first normal schools and the first organized teacher training institutions. The experience of the 1960's seems to indicate that the key to learning is individualization and the use of the student as a teacher is one way to increase this individualization. The concept of learning through teaching appears to be one of these basic ideas which works and it is finding a place in a variety of settings.

During the last several years, a few dozen schools in the United States have experimented with students teaching each other. The purpose seems to be to help the tutor, the tutee, or both. Compared to the tutee, the tutor may or may not be older, brighter, or more maladjusted; of a different socio-economic class; or attend the same school. The tutor may drag the tutee over teacher-prescribed remedial materials or he may teach a lesson he himself has planned for his pupil; he may serve as drillmaster, friend, consultant, guide, big brother, or teacher. Participants in tutoring programs may be volunteers or they may be selected by authorities; individual, classes, or special clubs set up for the purpose may be involved. Tutoring programs have so far been conceived, planned, and supervised by teachers, but there is no reason why students could not shoulder much of this responsibility.

Most of the pilot tutoring programs have been directed to elementary schools and some involve community volunteer groups.

In the early 1960's Peggy and Ronald Lippitt (1965) at the Institute for Social Research of the University of Michigan, began work using older elementary and junior high school students to work with younger Detroit elementary grade children in cross-age learning experiences. Their program involves older tutors working directly with the younger children for 20-50 minutes, three or four days a week in reading, writing, spelling, math, physical education, shop, and other activities. Sometimes the tutors would work with small groups as well as with the single individual. The success and continued operation of this program is dependently related to several behavior modifying outcomes. The behavior and attitude of the older tutors were recognized by the younger students as models for their own behavior. In essence the tutors became very potent and influential socialization agents. Since the older tutors worked closely with the adult teacher in a trust and responsible relationship, their collaborative involvement produces a significant socialization impact for the tutor.

The Lippitt's found that the "teaching students," assisting in a teaching function, were able to test and develop their own knowledge and discover the significance of that knowledge.

In the journal Education News (1968) a New York city program of student tutoring is reported. Each of thirty students enrolled in the teacher preparation program at Hunter College tutors one fifth or sixth grader in Public School 158. Each of these children then tutors a third grader on the lesson just taught by the college students. The college students spend six hours a week during one semester in the project; they hold their own seminar for four hours and they tutor and supervise tutors for two hours. The fifth-grade tutor and the third-grade tutee may be selected as having similar learning problems, and the college tutor plans a lesson that will benefit both children. Many benefits are claimed: the regular classroom teacher has assistance in dealing with learning problems of individual pupils; the older pupil gains new respect for himself and the teacher; the college students, invited to experiment with a microcosmic learning situation, are challenged to create learning activities and pedagogical principles. Cloward (1967) describes another New York city program involving peer mediated instruction. Program director, Dr. Albert Deering reports that a program called Homework Helper was developed by Mobilization for Youth, the Lower East Side anti-poverty agency, and has been operating in two school districts. It was expanded and offered to twenty-nine school districts and within six months 5,000 elementary school tutees and 2,000 high school tutors were busily at work within about 100 centers set up in neighborhood schools. The cost of the program was estimated to be about $1.2 million. According to the New York Times,

> "The tutors work with the pupils on a one-to one basis two days each week. They help them with their homework and then give them instruction in reading. High school and elementary teachers are assigned to the centers to supervise the tutors. The tutors are paid up to $2 an hour for their work . . . A study of the program released last year by Columbia University School of Social Work found that the tutors from slum areas not only helped their pupils but also made great improvements in reading themselves . . . (thus the tutees in the program showed a 6.2 month gain in their reading levels after 5 months. A control group that had had no tutoring showed the usual slum school rate, a 3.5 month gain in the same period.

> The tutors improved even more than their pupils. In a 7-month period their mean gain in reading level over their control group was a year and seven months."

Davis (1968) conducted an experimental study for eight months in which he used junior high school students to tutor other junior high students. It was hypothesized that in certain language skills, pupil-tutoring could produce positive changes that might be reflected in standardized test results and English grades among tutees as well as their tutors. In evaluating the progress of the tutors, Davis found a significant difference between the experimental and control groups in favor of the experimental group. No significant differences were found between the groups for the tutees.

Rogers (1969) reported, in an unpublished doctoral dissertation, an experiment conducted for eight weeks in the city school system of Tuscaloosa, Alabama. Sixth-grade children were used as tutors for third-grade children whose reading performance was below the median score for their grade. It was found that third-grade underachievers made significantly greater gains than their controls in reading achievement. The researcher also reported that even though reading gains were not significantly larger for sixth-grade tutors in the experimental group, the trend of the gains indicated that tutoring may be an effective remedial reading program for tutors as well.

Erickson (1971) conducted an experimental study concerning the efficiency of a tutorial program upon both tutors and tutees. The dependent variables were reading scores, grades, interests and attitudes, social acceptance and attendance.

The tutoring program was carried out for five months using seventh-grade boys as tutors and third-grade boys as tutees. The tutoring schedule consisted of two sessions a week for 30 minutes each. Results indicated improved reading scores for both tutors and tutees but no significant quantitative differences between the groups for the remaining dependent variables.

Gardner (1973) investigated the effects of intergrade tutoring upon the reading achievement, self-concept attitudes toward school and behavior of third and fourth-grade low achieving tutors. A secondary purpose of the study was to examine the effects of tutoring on the reading achievement and behavior of first and second-grade tutees. At the conclusion of the 10-week program, only negligible results were found in comparing experimental tutee groups' reading achievement with control tutee groups. However, all experimental tutor groups showed gains in reading achievement greater than those of tutor control groups. Neither experimental tutor or tutee groups showed gains in behavior greater than their respective control groups. Finally, all experimental tutor groups showed gains in self-concept and attendance compared to tutor control groups.

Peter S. Rosenbaum (1973), Associate Professor of Linguistics and Education at Teachers College, Columbian University, in his book entitled Peer Mediated Instruction describes several of his experimental programs employing a peer teaching strategy.

New York Public School 129 Spelling Project (1970)
New York Telephone Company Project (1971)
Jackson, Mississippi, Schools Project (1972)

The described instructional systems design, called Peer-Mediated Instruction directs students to do their work in pairs, interacting with one another according to a structural pattern of dialogue that insures for both members of the pair a successful learning experience.

The concept of peer teaching grows out of the author's earlier research on applying techniques of so-called "drill and practice" computer-assisted instruction (CAI) to language skills learning. He recognizes computers as good teachers, but Rosenbaum emphasizes that the success of many such CAI programs does not necessarily result from the hardware itself but dialogue between student and machine. Noting that CAI technology was prohibitively expensive anyway, he developed an instructional method based upon peer interaction that stimulates the key features of exemplary drill and practice CAI at a fraction of the cost. Dr. Rosenbaum, in his book <u>Peer Mediated Instruction</u>, p. 149, describes his strategy.

> "Almost from the first, however, classroom teachers with whom I was working advised me that pupils would also learn while performing as Teachers. And, too, the homespun wisdom that 'there is no better way to learn something than to teach it' frequently cropped up in discussions. Of course the classroom teachers were right. Not only do Students learn, Teachers learn also. The choice of terms for the roles of the dyad, 'Teacher' and 'Student,' turn out to be quite unfortunate because of the connotations that attach to the words 'teacher' and 'student;' they generally conjure the idea of someone who <u>knows</u> transmitting and imprinting what he knows upon someone who doesn't. But in a PMI system, these terms simply identify different, although interwoven, acts; <u>all</u> of <u>these acts</u>, whether Teacher initiated or Student initiated, address the course content as it exists in the materials of instruction.

> "In any case, a probable cause for the apparent potency of PMI is the simple fact that the two roles, Teacher and Student, force a multi-mode engagement with the subject matter in such intensity as has not heretofore been achievable under conventional classroom communication structures."

Unlike many peer tutoring methods that rely on advanced students for tutors, Rosenbaum's PMI strategy considers the tutor's skill level irrelevant. Tutors were provided with correct answers to every lesson exercise, so all they have to do is compare the answers to their classmates' responses.

> "PMI is favorably received and works well with students of many ages (from first grade through adulthood) and socioeconomic identification. It is especially effective for students of average or below average ability."

McGill University published a report of the Goldschmid (1970) "Learning Cell Study." The experimental design consisted of two options for peer interaction.

Option A consisted of an arrangement whereby both partners read the same assignment. The objective being to create in the classroom and between two students an intensive dialogue which served to check on and deepen the understanding of the reading as well as to exchange additional ideas and information pertaining to the chosen topic.

In option B the student partners in a learning cell read different assignments. In the classroom, for the first half of the period, student "A" of the dyad describes and explains the major points to student "B", then "A" asks his questions to check out "B's" understanding and corrects or elaborates if necessary. During the second half the roles are reversed; "B" communicates the substance of his reading and "A" responds to the questions. The Learning and Development Center of McGill University Vol. 2, No. 5 is quoted:

> "Goldschmid (1970) compared several learning options in a psychology course. Students were able to choose one method among the following four: seminar, discussion, independent study (essay), and learning cell. Despite the fact that there were no differences among the four groups of students at the beginning of the course with respect to personality as measured by the California Psychological Inventory, background characteristics - including the number of psychology courses taken, overall grade point average, major, etc. - (as measured by an extensive questionnaire), and knowledge of the subject of the course (as measured by a psychology content achievement pretest), students in the learning cell performed significantly better on an unannounced essay examination administered towards the end of the course. (It is still possible, of course, that students in the four groups initially differed on some trait not measured by the pretests). A 'morale barometer' was used to derive a subjective rating of the overall satisfaction with each class hour. This measure also demonstrated that the average rating of the learning cell was significantly higher than those of the other three methods. Finally, a comprehensive course evaluation the students completed after the course indicated the superiority of the learning cell method over the other three learning options."

Alden and Feldman (1973) describe research where peer teaching provided significant gains for low-achieving children.

Low-achieving fifth-grade children either taught a third-grader or studied alone for a series of daily sessions. At the end of the two-week period, the low-achievers' performance was significantly better in the tutoring condition than in the studying alone condition--a reversal in direction of the initial difference between conditions. There was no differential effect on tutees of being taught versus studying alone. Results suggest that serving as a tutor may be a particularly useful method for enhancing the academic performance of low-achieving children. The Alden report concludes:

> "In conclusion, enactment of the role of teacher by low-achievers seems to be a useful technique for increasing their learning. This results in more academically-successful students. The positive effects of teaching on the tutor may be most dramatic, however, in cases where the student has experienced a history of failure in a school situation using the more traditional pedagogical methods."

An instructional strategy which not only involves peer-assisted instruction but also peer testing and evaluation is described by Thiagarajan (1973) in <u>Educational Technology</u>.

> "Not all systems currently in use derive all these benefits from peer tutoring or testing. Many are interested primarily in learner gains. In this situation the above-average students--the ones to gain least from tutoring--get to tutor. It is also limited to remedial (and not initial) instruction, which unfortunately involves learners from the lower end of the distribution. Evaluation is missing in many systems of peer tutoring. However, in Personalized Systems of Instruction (Keller, 1968), periodic and repeatable unit tests and the requirement of mastery of each unit before going onto the next one are built in efficiently. Unfortunately, in this system, tutoring is only incidental, taking place during the discussion of the test performance of the learner.
>
> "I have recently field tested a system which combines peer teaching and testing. In this system each student is required to learn, teach, and test each unit of instruction before going onto the next one. <u>All</u> students--not merely the first to finish--get a chance to teach and test. Motivational responsibility is also shifted to the peer setting. Tutor, learner, and tester need each other to advance to the next step. This encourages the tutor to locate, motivate, and support a learner in addition to teaching him. Testing is done by another student member of the class, resulting in more objectivity and less leniency.
>
> "Thus far the system has been tested with high school students in Madras, India, and college students in Indiana. Its use has been limited to those parts of the course for which instructional and test materials have been developed. It is used for initial rather than remedial instruction. There seems

> to be no obstacles to prevent the adaption of the system to other settings and younger age groups."

In the Journal "Psychology in Schools," Jeane Crowder (1974) of the University of Kansas reports on a study conducted in an urban poverty area of Birmingham, Alabama. The objective of the study was to attempt a replication of previous findings where substantial gains were reported for both tutor and tutee in a peer-mediated instructional design.

Twelve eighth-grade tutors, who had participated in a seven-month tutoring program for deficient readers, were matched in terms of achievement and ability with 12 eighth-graders in the same school who had not participated in the previous tutoring program. The only requirements for tutoring were the desire to do so and a free daily class period. The experimental group was pretested and post-tested one year later, when the tutoring program ended, using the California Achievement Test. Tutors gained a median of 9 months in reading achievement during the seven-month tutoring program. However, the control group made a median gain of 11 months during the same period. A comparison of the gains made by the two groups indicate that the difference was not statistically significant and thus the tutoring experience did not appear to affect the reading level of the tutors. Dr. Crowder summarizes her findings:

> "While the gains of tutors reported previously may have been artifacts, there are other possible explanations. Different tutoring techniques may produce varying tutor gains. The techniques used in the present study were relatively structured and emphasized careful charting of progress. Other studies have used less structured approaches with

> an emphasis on the development of positive, flexible relationships between tutor and tutee. Similarly, different types of tutors may profit from tutoring to a greater or lesser degree. The tutors in this program actually were achieving already at or above the level expected when ability level is considered. Perhaps it is children with severe deficits who, as tutors, can make marked gains themselves. Until further research provides some definite answers, caution should be exercised when the virtues of tutoring experiences for tutors are described."

Summary

In classroom lectures and discussions we teachers try to reach and involve all our students because we feel that learning is an active experience, not a passive one. We no longer think of the student as a sponge, but rather as a participant in a two-way process of communication. Every teacher develops his own methods to help achieve this communication of ideas. One technique centers around drawing out questions from the students. An ideal situation of this type would be one in which a flow of questions came from all members of the class. But in the formal classroom situation the teacher is, in a sense, a barrier to the free flow of ideas simply because he is not one of the students. Although the personality of the teacher may range from the disinterested type on the one extreme to the "one of the boys" type on the other, his status is different. He represents the adult world and authority and to that extent inhibits the response of students.

When a student attempts to instruct his classmates, however, a new and dynamic factor seems to be injected into the learning experience, an element affecting both the student and his audience. There is something of the competitive spirit between student and class, a game to be participated in, a contest to be won, an enemy to be defeated. This relationship encourages a free flow of questions in which nearly all class members seem to become involved.

Recent experimental evidence indicates that a positive effect on learning does indeed occur for the student who enacts the role of teacher; in fact, the tutor may benefit more in many cases than the tutee.

Abundant anecdotal evidence suggests that the tutor may profit in several ways from his involvement in teaching; the tutor's motivation, sense of responsibility, and attitude toward school may show a positive shift. Encouraged by the prospect of positive effects when using older children to teach younger children, many schools have recently initiated some form of tutoring program. Yet, little in the way of systematic theory and research is available in this area.

The research studies conducted to date concerning student-to-student tutoring have not been entirely without methodological inadequacies. The main limitations of those reviewed include:

1. The reliability and/or validity of some of the instruments employed to gather data is questionable.

2. Experimental and control groups have not always been equated before the initiation of the experiment. In some instances (Rogers, 1969), subjects were matched on selected variables without being randomly assigned to experimental and control groups. While this may serve as a good compromise procedure, since it does tend to equalize the groups in reference to the variables matched, it does not equate the groups on what might be other relevant variables.

3. A few of the studies (Cloward, 1967a, 1967b; Davis, 1968) were conducted with what may have been a biased sample, since available students were used as subjects without any type of random selection. This, of course, limits the generalizations that can be made in regard to the findings of the study.

4. The Hawthorne Effect was not always controlled. Knowledge that an experiment was being conducted may have caused some subjects to change in relation to the criterion measure(s). This is true of nearly all the research studies reviewed.

In summary, it can be said that additional research that is more tightly controlled is needed before position papers advocating student-to-student tutoring as a means to individualize instruction can be realistically evaluated. This conclusion is based on the ambiguous findings and obvious limitations of some of the research conducted to date.

CHAPTER FOUR

EXPERIMENTAL DESIGN

Rationale

For sometime educators have agreed that instruction, if it is to be successful, must be directed toward a mass of students gathered in some lecture hall. It is generally known that each student brings to the learning experience a diverse background demanding that instruction, if it is to be meaningful, be tailored to his individual requirements. Background greatly affects the ability and capability of each student to such an extent that it is assumed that, if the quality of learning is dependent upon a large number of variables, then it would be improbable that any two persons would be ready for the same instruction from the same media at the same time. It seems, then, that we must fit the subject matter presentations to the individual requirements of the learner so that what is unique or special about every learner, that may affect his achievement, will be taken into consideration.

Education reform for the 1970's cries out for instructional strategies that recognize individual differences and learning rates; for a methodology that both challenges and motivates. Students deserve an educational format that allows for active participation and involvement; where enrichment and self-realization are also desired educational objectives. Peer meditated and computer augmented instruction may answer many of these challenges.

Most of the Peer Assisted Learning research has been conducted in the elementary grade levels or through community service agencies. There is no documentation for a peer teaching strategy in the area of college level undergraduate Human Anatomy. That is not to say that the theoretical construct of peer teaching could not be applied to this subject area. In fact, I believe it can be and quite successfully.

Most of the reported research supporting computer augmented teaching has been in the math and physical science areas.

The computer is programmed to tirelessly generate mathematical or physics problems to be solved. The students are drilled at the computer terminal rather than the chalk board. The computational skills of students are perfected through repetitive drill and practice. The structural detail of Anatomy and Terminology spelling compares similarly to the detail and precision required in mathematics. The logical extension would suggest similar learning gains for Anatomy using computerized drill and practice as demonstrated for many mathematical and physical science models.

The drill and practice mode of CAI would appear to offer the greatest adjunct to Anatomy instruction. The Simulation and Tutorial modes too closely resemble the "ill-fated" teaching machine. Certainly the choice of strategic mode and the fine detail of program design and delivery lacks for a secure theoretical base.

According to Suppes (1969b) "the principal obstacles to computer-assisted instruction are not technological but pedagogic." Most of the computer techniques employed to date are based on pure and simple "pedagogical intuition." CAI awaits for more soundly based theoretical approaches. Interestingly, most likely it will be the power of the computer that may well lead to the development and confirmation of new educational theories suitable for CAI. The computer's ability to record and subsequently analyze the reactions of great numbers of CAI program and system users may affect substantative evaluation and pedagogical development.

Computers are now so much a part of our lives, and even more so for the future, that quite soon a basic knolwedge of computers will not only be useful, but perhaps be essential in order to be considered "literate."

The drill and practice mode of computer tutorage is indeed the least complex of all the CAI modes. However, its simplicity should not malign its effectiveness as a supplement to classroom instruction. Numerous studies in the literature have repeatedly confirmed "Drill and Practice" as an effective and fruitful adjunct to the instructional process. Computer managed "Drill and Practice" should be correctly viewed as supplemental instruction and reinforcing in nature. Nevertheless, this mode is entirely under computer control with considerable interaction between computer and learner and as such, is certainly full-fledged CAI.

The choice of this particular CAI mode for supplemental instruction in the area of Human Anatomy, is most appropriate.

The strong terminologic emphasis necessary for an understanding of anatomic detail, commonly requires that the student learn by repetition, association and self-disciplined drill. A common learning strategy for the Anatomy student involves repetitive reading, repetitive writing, and repetitive verbalization, with self-testing and self-evaluation. The self-discipline and motivation required for such learning is often limited and engenders fatigue and promotes short-term recall.

A computer-managed drill and practice strategy introduces the element of competition, "man versus the machine." The computerized program will tirelessly drill and test the user, and by reporting the student score, the challenge is thereby made to do one's best and beat the machine. I propose, that by tempting the learner with this "mechanized carrot," learning becomes more efficient, less routine and more fun. The thrust of this research is to ascertain the effectiveness of a teaching strategy that has peer interaction and computer teaching as an instructional experience complimentary to the lecture format.

Research Design

When selecting an experimental design, the researcher must be cognizant of several factors which may well jeopardize the validity of any findings. These concerns for validity must include internal validity--did the experimental treatment really have an effect??--and external validity or generalizability--to what populations, settings, treatment variables, and measurement variables can this effect be generalized?? Both types of criterion are obviously important, even though they are frequently at odds in that features increasing one may jeopardize the other. Clearly, an experimental design must insist on internal validity else the entire exercise becomes futile. In educational research, particularly, the generalizability to other applied settings becomes the sought goal.

In regards to internal validity there are essentially eight extraneous variables which might easily produce effects confounded with the effect of the experimental treatment and obviously the neutralization of these variables is required:

1. History: Specific events occurring between the first and second measurement in addition to the experimental protocol.

2. Maturation: The biological and/or psychological processes occurring over a passage of time which might affect individual response (hunger, fatigue, aging).

3. Testing: The prompting or potentiating effect of taking a test upon the scores of a second test. Most influential in the traditional Pretest to Post-test design.

4. Instrumentation: Variation in the calibration or design of the measuring instrument in examination may produce changes in the obtained data.

5. Statistical Regression: Operating with groups selected on some basis of their extreme scores (lower percentiles, disadvantaged, gifted).

6. Statistical Biases: The non-random or differential selection of respondents for comparison groups.

7. Experimental Mortality: The loss of respondents for the comparison groups.

8. Multiple Effect: Interaction of several variables (Selection-Maturation) which become confounded with the experimental treatment and bias the outcome.

The single variable that most often influences the representatives or external validity of the experimental design is the repetition effect of testing.

9. Interaction Effect of Testing: Pretesting might increase or decrease the respondent's sensitivity or responsiveness to the experimental variable and thus make the results obtained for a pretested population unrepresentative of the effects of the experimental variable for the unpretested universe for which the experimental respondents were selected.

The classical Solomon Four-Group design was selected for this research, not only because it has a higher prestige among educational researchers, but also because this design would control factors influencing external validity.

Six randomly equated groups were drawn from college students currently enrolled in Human Anatomy, Physiology and Medical Terminology at Delta College. The mean group size was 25.

Group One	=	28 students
Group Two	=	26 students
Group Three	=	31 students
Group Four	=	23 students
Group Five	=	21 students
Group Six	=	19 students
Total		148 students

The Solomon Four-Group design in my research to evaluate the PAL and CAI experimental protocol might be illustrated thusly:

Randomly Equated		Testing over Time	
Group One	Pretest	Instruction Using PAL/CAI Experimental Protocol	Post-test
Group Two	Pretest	Traditional Lecture/Lab Instruction	Post-test
Group Three	Not Pre-tested	Instruction Using PAL/CAI Experimental Protocol	Post-test
Group Four	Not Pre-tested	Traditional Lecture/Lab Instruction	Post-test
Group Five	Not Pre-tested	Instruction Using PAL Protocol Only	Post-test
Group Six	Not Pre-tested	Instruction Using CAI Protocol Only	Post-test

This experimental design controls for all of the nine listed challenges to validity, both internal and external.

History is controlled insofar as general events that might have produced a significant difference between Pretest and Post-test scores of the experimental groups would also produce a similar Pretest and Post-test difference for the control group.

Maturity and Testing are controlled in that they should be manifested equally in experimental and control groups. Instrumentation was controlled by having the respondents complete a printed test. Regression is controlled as far as mean differences are concerned since both the experimental and control groups were randomly assigned from the same pool; therefore, the control group would regress as much as the experimental group. Selection Bias is ruled out as an explanation of differences to the extent that randomization has assured group equality from the onset of the research.

In summary, the control of these variable main effects in the experimental design assure internal validity.

The threats to external validity for the Solomon Six-Group experimental design involve interaction effects of the experimental protocol and some other variable, namely the influence of pretesting. There are valid designs avoiding the pretest and often it is to unpretested groups that one wants to generalize. Therefore, such designs are often preferred on grounds of external validity or generalizability. In the area of teaching, the doubts frequently expressed as to the applicability in actual practice of the results obtained by highly artificial experimentation are certainly judgments about external validity. The influence of pretesting on the effects of an experimental treatment; first described by Solomon in 1949, is a function of the extent to which such repeated measurements are characteristic of the universe to which one wants to generalize. In educational research, one is interested in generalizing to a setting in which testing is a regular phenomenon. Further, by using regular classroom examinations for testing, one may safely assure that no undesirable interaction of testing and the experimental treatment will be present.

Certainly one significant feature of the Solomon design is its explicit consideration for external validity factors. Thus, by paralleling the common pretest, post-test, control design with experimental and control groups lacking the pretest, both the main effects of testing and the interaction of testing and the experimental protocol are determinable. In this way, not only is generalizability increased, but in addition, the effects of the experimental protocol is replicated in four different ways with these expected results.

> Post-test scores of the experimental group will be significantly greater than pretest scores for the experimental group.
>
> Post-test scores of the experimental group will be significantly greater than post-test scores of the control group.
>
> Post-test scores of the experimental group not pretested will be significantly greater than post-test scores of the control group not pretested.
>
> Post-test scores of the experimental group not pretested will be significantly greater than pretest scores of the experimental group pretest.

Because of omnipresent experimental variation and instability, it clearly becomes imperative that these comparisons must be in agreement if any broad generalizable influence is to be made.

A total of 148 students were divided into six groups to conform to the Solomon array. The first and second groups were pretested as to their prerequisite knowledge of osteology. The testing instrument consisted of 20 questions requiring a written response containing items representative of the behaviors expected for this instructional unit. This particular testing format was employed so that spelling could also be evaluated. Groups Two and Four received the usual instruction, based on lecture-recitation and laboratory demonstration. Groups One and Three also received the traditional lecture, but in addition these two groups participated in the Peer Assisted Learning and Computer-Assisted Instruction activities. Experimental Groups Five and Six received the

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supplementary instructional protocols as independent strategies. Group Five only received PAL supplements and Group Six only received CAI supplements. All groups received the same post-test having the same format as the pretest, but consisting of a different assortment of test items (see Appendix A and B).

The Kuder-Richardson and Hoyt reliability coefficient was routinely computed for both pretest and post-test responses. All reliability coefficients were greater than 0.60 which would indicate that the individual items on the tests were producing similar patterns of response in different individuals. Therefore, the high coefficient value confirms that the test items were homogeneous and consequently reliable.

The research design essentially involves an evaluation of instructional experiences supplemental to the classroom lecture. By pretesting not only is prerequisite knowledge determined, but also the statistical analysis of pretest scores enables an evaluation of homogenity between control and treatment groups.

The instructional sequence for both the control and treatment groups is illustrated diagrammatically.

INSTRUCTIONAL UNIT LECTURE

CONTROL GROUPS

GROUP TWO
PRETESTED

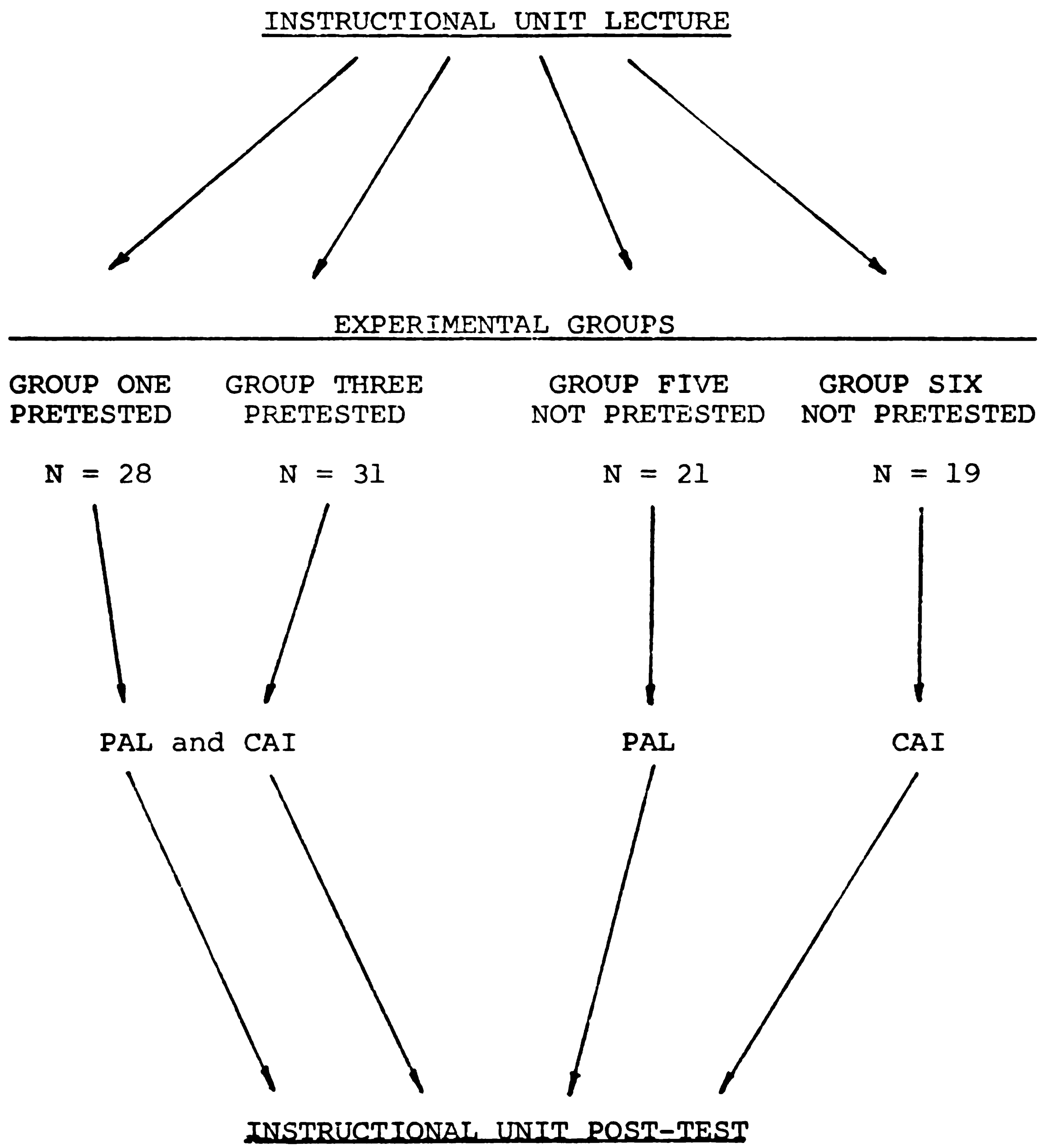
N = 26

GROUP FOUR
PRETESTED

N = 23

TRADITIONAL
LABORATORY EXPERIENCE

INSTRUCTIONAL UNIT POST-TEST


INSTRUCTIONAL UNIT LECTURE
EXPERIMENTAL GROUPS
GROUP ONE
PRETESTED
N = 28
GROUP THREE
PRETESTED
N = 31
GROUP FIVE
NOT PRETESTED
N = 21
GROUP SIX
NOT PRETESTED
N = 19
PAL and CAI
PAL
CAI
INSTRUCTIONAL UNIT POST-TEST

Composition of Research Groups

The open door admission policy of the community college registers students into classes simply on a first come basis. The student has the option to enroll into any desired section of a course, provided space is available. The usual tracking by ability or prerequisite is not employed.

As a result, each course section contains a random assortment of abilities, background, and prerequisite preparation. For this study, the random assignment of Delta College registration procedures was relied on to establish equivalent class sections and, therefore, randomly equated experimental groups.

Each student was asked to complete a "Biographical Data" questionnaire. The questionnaire was designed to enable assessment of individual student backgrounds and especially to enable a statistical comparison of student composition for each test group. The format of this questionnaire is presented in Appendix F. The student responses for each experimental group is summarized in RESPONSE TABLE ONE.

In addition, the experimental design requires Group One and Two to be pretested before receiving the experimental treatment. A statistical comparison of these pretest scores showed no significant differences which further supports the equivalency of each group. This statistical comparison is summarized in DATA TABLE ONE.

The typical composite student for this research would be a 24-year old female, having only a high school education with an overall GPA of 2.6 or B-. The composite has completed high school science and biolcgy and majors in an allied health curriculum.

RESPONSE TABLE ONE

COMPOSITION AND BACKGROUND DATA FOR EXPERIMENTAL AND CONTROL GROUPS

	Control Groups	Group Receiving CAI and PAL	Group Receiving CAI	Group Receiving PAL
SEX: #	49	62	19	21
Male	4	3	-	1
Female	45	59	19	20
AGE: (Frequency in Percentage)				
17-19	.48	.50	.32	.41
20-22	.20	.21	.14	.19
23-25	.02	.05	.09	.06
26-28	.01	.04	.06	.08
29-31	.01	.02	.05	.02
32-34	.01	.01	.04	.02
over 35	.27	.17	.30	.22
Mean Age	24.9	23.6	25.1	24.4
HIGH SCHOOL GPA: (Frequency in Percentage)				
1.0-1.9	.09	.06	.08	.10
2.0-2.4	.19	.21	.23	.20
2.5-2.9	.16	.14	.19	.16
3.0-3.4	.32	.33	.33	.35
3.5-4.0	.24	.26	.17	.19
Mean GPA	2.71	2.76	2.64	2.66

COMPOSITION AND BACKGROUND DATA FOR EXPERIMENTAL AND CONTROL GROUPS (Continued)

	Control Groups	Group Receiving CAI and PAL	Group Receiving CAI	Group Receiving PAL
EDUCATIONAL BACKGROUND:	(Frequency in Percentage)			
H.S. only	.54	.56	.48	.58
1 yr. college	.32	.34	.29	.31
2 yrs. college	.07	.05	.10	.07
3 yrs. college	.05	.04	.07	.03
College Degree	.02	.01	.06	.01
BIO-SCIENCE COURSES COMPLETED:	(Frequency in Percentage)			
H.S. Health	.58	.61	.68	.66
H.S. Gen. Science	.59	.57	.54	.60
H.S. Biology	.84	.78	.82	.87
H.S. Adv. Biology	.14	.08	.07	.11
H.S. Human Biology	.06	.03	.02	.04
H.S. Physiology	.03	.01	.01	-
Col. Biology	.09	.02	.01	.01
Col. Anatomy	.01	-	-	-
Col. Physiology	.01	-	-	.01
PREVIOUS COMPUTER EXPERIENCE:	(Frequency in Percentage)			
Yes	.18	.11	.19	.09
No	.82	.89	.81	.91

Control and Experimental Instructional Formats

The Anatomy, Physiology and Medical Terminology course at Delta College is a twelve-credit (two-semester) course specifically designed for Allied Health majors. The instructional schedule includes 2 hours of lecture-demonstration-laboratory, three times weekly for 15 weeks each semester. The lecture is supplemented with audio-visual and printed material. Precise behavioral objectives are distributed for each instructional unit and testing measures mastery of these objectives. During the laboratory-demonstration periods students are shown pro-sections of laboratory animals, models and on occasion they may conduct typical physiologic experiments. The traditional format would involve terminology presented in lecture, and reviewed in workbook exercises. In general, opportunities for drill and practice in the classroom were either limited or non-existent.

As typical of most lecture based classes, the drill and practice often comes the night before the examination and is not a formal part of classroom strategy. However, this socratic strategy is often successful in producing significant gain scores in spite of its inheritant weaknesses and disregard for individual differences.

Student Groups One and Three received the experimental protocol that supplemented the usual instructional strategy. Students of Group One were first pretested over general osteology, using the same twenty-item pretest instrument administered to the control Group Two. Students of Group Three were not pretested, but they received the identical experimental instruction as Group One, namely, lecture-recitation, augmented with computer and peer assisted learning opportunities. Three weeks later, after 18 classroom hours of instruction, including computer and peer assistance, both experimental Groups One and Three were post-tested for achievement using the twenty-item post-test administered to the control group.

The control protocol administered to Groups Two and Four might be illustrated thusly:

Instructional Unit Pretest (Group Two)

9 Hours of Lecture

9 Hours of Traditional Laboratory

Unit Post-test

The experimental protocol administered to Groups One and Three might be illustrated thusly:

Instructional Unit Pretest (Group One)

9 Hours of Lecture

6 Hours of Peer Interaction Sessions

3 Hours of Computer-Assisted Drill and Practice Instructional

Unit Post-Test

Both the control Groups Two and Four and the experimental Groups One and Three attend the same lecture given by the author. The three-hour lecture each week was structured from the instructional behavioral objectives. For the osteology unit a total of 9 lecture hours was presented to all groups. The lecture outline for the osteology unit is found in Appendix C. The student behavioral objectives for this osteology unit is found in Appendix D. The lecture is richly illustrated with color transparencies and 2 x 2 color slides. Models and displays were used to illustrate relevant concepts, such as "bone types," "bone sections," and "skull anatomy." Even with a class size of over 100, student questions were encouraged and incorporated into the lecture presentation.

All students were expected to attend three hours of laboratory sessions each week. The activities for these laboratory sessions were designed to supplement and reinforce concepts presented in lecture. Also, because of their small size (20-25), such sessions provide opportunities for individual assistance and instruction.

For the osteology unit, students had the opportunity to assemble and examine human skeletal material. Provided laboratory guides directed the students to important osteology features and in particular, those required in the behavioral objectives. In many ways the format for these laboratory sessions followed the traditional protocol whereby most of the activities and learning strategy involved the individual working in a group setting. On occasion "lab partners" or small groups of students were formed, but for the most part, no organized, well-structured, format was designed that encouraged or required peer interaction. Such volunteer peer associations has long been the tradition of similar laboratory sessions. These experiences can be successful but their failure to provide active student participation, encourage student passivity and discourage the less motivated student. Traditional laboratory sessions have been justly criticized for their failure to provide meaningful educational experences. Their lack of structure and direction often leads to an inefficient waste of time for all concerned.

Control Groups Two and Four attended laboratory sessions similar in design to those found in most undergraduate science laboratories. Pro-sections, models, displays, film-loops, histologic and other usual instructional media and materials were available. Each student was directed to important features of the material by referring to their laboratory guide. There was no testing during these periods. The course instructor would circulate throughout the laboratory to provide assistance and instruction.

Experimental Groups One and Three attended laboratory sessions where peer interaction was required or encouraged by design. Students were assigned or volunteered to small study groups of four or five. Each group was responsible for a portion of the instructional assignment. Their group task was to master assigned learning objectives. Each of two groups had different but related learning tasks. For example, two groups of 4-5 students were responsible for anatomic features of the arm and shoulder whereas the remaining two groups of 4-5 students were responsible for anatomic features of the leg and pelvic girdle. Using the same laboratory guides as the control group, the experimental groups would review the required features in a group dynamic setting. Often individual assignments were made within the small experimental groups such that each student was forced into an active, participating role. Group pressure and peer expectations became strong motivating factors which encouraged individual contribution.

Once each group had fulfilled the learning objectives for that session, two groups with dissimilar but related objectives were brought together for a joint interaction session. In these combined sessions, students were compelled to assume the role of teacher and instruct members of the group. The individual would present the material he had learned (e.g. the anatomy of the scapula) and be in a position to answer questions regarding "his" bone or assignment. In its simplest form we would have students versed in skeletal anatomy of the arm sharing, instructing and interacting with the other group assigned the skeletal anatomy of the leg. The "teacher" role requirement of such interaction necessitates active participation by all. Failure to provide your assignment leads to peer admonishment and the potent force of peer rejection.

Such a format for the laboratory sessions provided a lively and highly productive experience. Other topics that were paired and managed by similar peer group interactions included: osteology of the arm--osteology of the leg--osteology of the shoulder girdle--osteology of the pelvic girdle--osteology of the hand--osteology of the foot--paired bones of the skull--unpaired bones of the skull.

The course instructor assumed the role of resource person and coordinator for the laboratory sessions.

Experimental Groups One and Three were also provided with computer assistance for drill and practice of osteology material. An instructional program was written in the comp

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computer language BASIC and made available to students through a time sharing arrangement with the Dartmouth College computer in Hanover, New Hampshire. The program consisted of a pool of 200 drill items derived from the osteology behavioral objectives. Although the format of presentation varied somewhat from "fill in the blank" statements to single word identifications, the student was required to respond with correct spelling via teletype terminals located at Delta College, University Center, Michigan.

By using a random number generator to determine the branching sequence and a matrix design, it was possible to randomize the order of drill items for each practice session. In this way, the same student could return as often as desired without repetition. In general, because of time commitments or fatigue, students would only drill and practice with the computer for 60-90 minutes and respond to 50-75 items. The computer was programmed to keep score and report to the student the cumulative number of correct and incorrect responses as well as the percentage of correct responses. This report of score was made to the student after each item; in this way, the students often perceived the computer interaction as a contest. When the student concluded and signed off the terminal, their total score would be stored into a file for later access. Such stored data became, in part, the Data base for this study. The stored information consisted of student's name, items attempted, percentage correct, data and time. The following is a sample of the stored student data for January 23, 1975, which was accessed from computer memory one week later (see report sheet). The complete program for the

```
DARTMOUTH TIME-SHARING
LINE 2/Ø441 ON AT 11:34  30 JAN 75, 133 USERS
LIST CCNEWS*** 11/20/74

USER NUMBER--E06683, [redacted]
NEW OR OLD--OLD SCORE
READY

LIST

SCORE      30 JAN 75 11:35

LORI KWATER       29 ATTEMPTS    62 PERCENT   1/23/75   16:42:57
SHAR LINCOLN      38 ATTEMPTS    6Ø PERCENT   1/23/75   1Ø:48:Ø8
LORI KWATER       4Ø ATTEMPTS    52 PERCENT   1/23/75   17:13:1Ø
DOROTHY KING      29 ATTEMPTS    62 PERCENT   1/23/75   1Ø:58:47
GLORIA SABIAS     15 ATTEMPTS    66 PERCENT   1/23/75   13:53:17
MARION WARE       34 ATTEMPTS    88 PERCENT   1/23/75   11:Ø1:ØØ
MARIANNE MALOTT   45 ATTEMPTS    82 PERCENT   1/23/75   11:12:Ø7
CINDY ANDERSON    73 ATTEMPTS    76 PERCENT   1/23/75   11:54:15
GLORIA SABIAS     64 ATTEMPTS    75 PERCENT   1/23/75   13:51:Ø1
KEVEN CONLEY      4Ø ATTEMPTS    62 PERCENT   1/23/75   11:47:43
BILL HURLES       36 ATTEMPTS    5Ø PERCENT   1/23/75   18:13:11
JAN WOOD          57 ATTEMPTS    77 PERCENT   1/23/75   1Ø:22:Ø1
SANDY GOSKO       54 ATTEMPTS    75 PERCENT   1/23/75   12:15:4Ø
DEBBIE DOYLE      82 ATTEMPTS   1ØØ PERCENT   1/23/75   12:24:14
READY


UNSAVE
READY
```

osteology unit is presented in Appendix E. An additional feature of this program enables the student to self-test by commanding a random assortment of test items to be printed at the terminal. Also, once the student decided to end the drill and practice session, she could do so by typing "NO" to the question "DO YOU WANT ANOTHER ITEM?" At this point, the student would have the option to reexamine any of the previously attempted items in order to test a different response or different spelling.

The students had 15-hour availability to the terminals, Monday through Saturday.

Students of experimental Groups One and Three were required to schedule one hour of computer interaction each week. This arrangement would insure for each student a total of three hours of computerized drill and practice for the three-week instructional unit. The computer was programmed to store utilization data and student identification so that the required interaction could be supervised.

The computer was programmed only to accept correct spelling but where two or more possible answers were acceptable, the computer would accept either one. This strategy was designed to encourage accurate spelling and precision in selection of response choice. The instructor could easily monitor class progress and utilization of computer assistance by having the computer print out the stored names and related data of terminal users.

Following an orientation session the students were free to schedule time on the computer when they wished. Even though students were encouraged to drill and practice individually, peer or colleague interaction was never denied. The prevailing honor system would assure that correct names and data were entered for research evaluation. It was made clear to the students that their interaction with the computer was not a testing experience and that their score would not be recorded for course evaluation purposes. The instructor was only interested in utilization and achievement correlations.

Ancillary Studies

Several subordinate investigations were part of the major study.

Study Time

Students for all research groups were required to log the time spent for examination preparation. This study time would be submitted with the post-test and was meant to be the student's best estimate of the time necessary to prepare for the achievement test. Students were assured that this information was meerly for research purposes and not a part of the evaluation process.

Spelling Accuracy

The post-tests required a short written response. Electronic scanning and grading was not employed so that spelling accuracy could be evaluated and correlated with instructional strategy.

Retention

All students were repost-tested after a six-month period in order to correlate retention with instructional strategy. This intention was not announced to the research participants to preclude advanced preparation.

Attitudinal Evaluation

All research participants were required to complete an attitudinal questionnaire consisting of both open-ended and specific inquiries. See Appendix I and J for questionnaire format.

Research Hypotheses

1. Because of randomly equated assortment of research groups, there will be no significant difference in pretest scores for control Group Two and experimental Group One.
2. The post-test scores of control Group Two, receiving the traditional instructional program, will be significantly greater than pretest scores for this group.
3. There will be no prompting influence for pretesting in the experimental groups such that post-test scores of pretested Group One will not be significantly greater than post-test scores of the experimental Group Three that was not pretested.
4. There will be no prompting influence for pretesting in the control groups such that post-test scores of the pretested control Group Two will not be significantly greater than post-test scores of control Group Four that was not pretested.
5. The instructional protocol of PAL + CAI for Groups One and Three will produce significantly higher post-test

scores as evidenced by the following comparison:

a. When experimental Group One pretest scores are compared with experimental Group One post-test scores.

b. When experimental Group One pretest scores are compared with experimental Group Three post-test scores.

c. When control Group Two post-test scores are compared with experimental Group One post-test scores.

d. When post-test scores of experimental Group Three (not pretested) is compared with post-test scores of control Group Four (not pre-tested).

e. When post-test scores of both experimental Groups One and Three are compared with the post-test scores of both control Groups Two and Four.

6. The experimental protocol of PAL + CAI will be significantly more effective in the combined format such that post-test scores for experimental Groups One and Three receiving the combined treatment will be greater than post-test scores for Groups Five and Six, receiving independent treatments of PAL and CAI.

7. The average examination preparation or study time will be significantly less for experimental Groups One and Three than for control Groups Two and Four.

8. The mean number of post-test spelling errors will be significantly less for Groups One and Three receiving the experimental PAL + CAI treatment, than for control Groups Two and Four.

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9. Six-month retention as measured by repost-testing will be significantly greater for Groups One and Three receiving the experimental protocol than for control Groups Two and Four.

10. Students receiving the experimental protocol of PAL + CAI will report a favorable attitude for this instructional strategy.

CHAPTER FIVE

RESEARCH FINDINGS

The Solomon array as an experimental design allows for testing treatment effects or internal validity by four different statistical comparisons.

1. Post-test achievement compared with Pretest scores.
2. Post-test achievement for the nonpretested group compared with the Pretest scores of the Pretested group.
3. Post-test achievement for experimental group compared with Post-test achievement of control group.
4. Post-test achievement comparisons between control and experimental groups not pretested.

The Solomon Four Group experimental design used in this research could be illustrated thusly:

Randomly Equated		Research Design Testing over Time	
Group One	Pretest	Instruction Using Experimental Protocol	Post-test
Group Two	Pretest	Traditional Instruction	Post-test
Group Three	No Pretest	Instruction Using Experimental Protocol	Post-test
Group Four	No Pretest	Traditional Instruction	Post-test

There is no single statistical procedure which makes use of all six sets of observations simultaneously. The asymmetries of the total six-cell design rule out the usual analysis of variance of gain scores. A structure of the Post-test scores into the following array would permit several statistical analyses.

	Instruction Augmented with PAL and CAI	Usual Instructional Format Lecture-Demonstration
Pretested	Group One	Group Two
Not Pretested	Group Three	Group Four

From the column data, one estimates the main effects of the experimental protocol or the internal validity of the research. From the row means, one estimates the influence of pretesting or external validity. From the cell data one can estimate the interaction of testing with the experimental protocol.

An analysis of variance program was written in computer language BASIC and made operational on the Dartmouth Time Sharing System. See Appendix E for the full program.

STATISTICAL ANALYSIS TO TEST FOR RANDOM DISTRIBUTION OF TEST SUBJECTS

If students were indeed placed into the research experimental cells randomly as the result of existing registration procedures, one would expect no significant difference in pretest performance for Groups One and Two.

Research Hypothesis No. 1

Because of randomly equated assortment of research groups, there will be no significant difference in pretest scores for control Group Two and experimental Group One.

Research Findings:

Experimental Group One	n = 31	Pretest Mean = 61.6 $\pm$ 6.2
Control Group Two	n = 26	Pretest Mean = 60.1 $\pm$ 9.8

F Value = 0.06; Critical F = 4.02
Variance of Means NOT significant, $P = > .05$
See Data Table One, Appendix K

This finding plus inspection of compositional data (Response Table One) confirms that research groups were equated, and, therefore, treatment effect inferences between groups should have validity.

STATISTICAL ANALYSIS TO TEST FOR EFFECTIVENESS OF TRADITIONAL TEACHING

The usual or traditional instruction also produced significant achievement gains. It would certainly be desirable that the teaching strategy used by most instructors, namely, the lecture-demonstration, produced significant learning.

Research Hypothesis No. 2

The post-test scores of control Group Two, receiving the traditional instructional program will be significantly greater than pretest scores for this group.

Research Findings:

Control Group Two	$n = 26$	Pretest Mean $= 60.1 \pm 9.8$
Control Group Two	$n = 26$	Post-test Mean $= 78.4 \pm 6.0$

F Value = 10.44; Critical F = 4.03
Variance of Means significant, $P = < .001$
See Data Table Two, Appendix K

These highly significant results would support the effectiveness afforded the traditional lecture-laboratory format of undergraduate anatomy instruction. There is certainly no contention that traditional methods fail to produce achievement.

STATISTICAL ANALYSIS TO TEST FOR PROMPTING INFLUENCE OF PRETESTING

The major threat to the external validity of this research design involves the possible interaction of pretesting with the experimental protocol. It was certainly hoped that pretesting, especially for the short (three-week) experimental period, would have no measurable effect on post-test scores, thus enabling generalizable inferences to be made for the experimental treatment.

Research Hypothesis No. 3

There will be no prompting influence for pretesting in the experimental groups such that post-test scores of pretested Group One will not be significantly greater than post-test scores of the experimental Group Three that was not pretested.

Research Findings:

Experimental Group One	$n = 25$	Post-test Mean = 87.9 ± 4.9
Experimental Group Three	$n = 31$	Post-test Mean = 83.6 ± 3.8

F Value = 2.05; Critical F = 4.02
Variance of Means NOT significant; $P = > .05$
See Data Table Seven, Appendix K

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STATISTICAL ANALYSIS TO TEST FOR PROMPTING INFLUENCE OF PRETESTING

Research Hypothesis No. 4

There will be no prompting influence for pretesting in the control groups such that post-test scores of the pretested control Group Two will not be significantly greater than post-test scores of control Group Four that was not pretested.

Research Findings:

Control Group Two	n = 26	Post-test Mean = 78.4 $\pm$ 6.0
Control Group Four	n = 23	Post-test Mean = 73.4 $\pm$ 6.4

F Value = 1.33; Critical F = 4.04
Variance of Means NOT significant; P = $>$ .05
See Data Table Three, Appendix K

The failure to find significant differences in post-test scores for the pretested groups and those not pretested, in either the control or experimental groups, would allow the assumption that pretesting had no effect on resulting post-test scores.

STATISTICAL ANALYSIS TO TEST FOR EFFECTIVENESS OF THE TREATMENT PROTOCOL PAL & CAI

A critical statistical comparison would be between post-test scores of students receiving the traditional educational format compared to post-test scores of those receiving the experimental protocol.

Research Hypothesis No. 5

The instructional protocol of PAL + CAI for Groups One and Three will produce significantly higher post-test scores as evidenced by the following comparisons:

a) When experimental Group One pretest scores are compared with experimental Group One post-test scores.

b) When experimental Group One pretest scores are compared with experimental Group Three post-test scores.

c) When control Group Two post-test scores are compared with experimental Group One post-test scores.

d) When post-test scores of experimental Group Three (not pretested) are compared with post-test scores of control Group Four (not pretested).

e) When post-test scores of both experimental Groups One and Three are compared with the post-test scores of both control Groups Two and Four.

Research Findings:

a) Experimental Group One n = 31 Pretest Mean = 61.6 $\pm$ 6.2
Experimental Group One n = 25 Post-test Mean = 87.6 $\pm$ 4.9

F Value = 41.85; Critical F = 4.19
Variance of Means significant, P = $<$.001
See Data Table Four, Appendix K

b) Experimental Group One n = 31 Pretest Mean = 61.6 $\pm$ 6.2
Experimental Group Three n = 31 Post-test Mean = 83.6 $\pm$ 3.8

F Value = 23.26; Critical F = 4.02
Variance of Means significant, P = $<$ .001
See Data Table Nine, Appendix K

c) Control Group Two n = 26 Post-test Mean = 78.4 $\pm$ 6.0
Experimental Group One n = 25 Post-test Mean = 87.6 $\pm$ 4.9

F Value = 5.74; Critical F = 4.03
Variance of Means significant, P = $<$ .025
See Data Table Five, Appendix K

d) Control Group Four n = 23 Post-test Mean = 73.4 $\pm$ 6.4
Experimental Group Three n = 31 Post-test Mean = 83.9 $\pm$ 3.8

F Value = 9.03; Critical F = 4.03
Variance of Means significant, P = $<$ .005
See Data Table Six, Appendix K

e) Control Groups Two and Four n = 49 Post-test Mean = 76.1 $\pm$ 4.6
Experimental Groups One and Three n = 56 Post-test Mean = 85.3 $\pm$ 3.2

F Value = 12.82; Critical F = 3.95
Variance of Means significant, P = $<$ .001
See Data Table Ten, Appendix K

Analysis of the variance in gain scores between these groups shows significant improvement in achievement for those receiving the experimental protocol. Clearly, the augmentation of instruction with peer teaching sessions and supplementary computer drill and practice produces significant achievement.

In each comparison described one finds the level of achievement to be significantly greater for those students experiencing the experimental protocol. A summary statistical comparison is presented in Data Table Ten, Appendix K, where the two post-test scores of those classes receiving the usual lecture-demonstration instruction were compared with the two post-test scores of those classes receiving the experimental protocol.

Analysis of variance shows a significant difference between these post-test scores. The combined control groups

had a mean post-test score of 76%. The combined experimental groups had a mean post-test score of 85%. The larger mean score for those receiving the experimental protocol was significant at the .001 level. This evidence would confirm the beneficial effects of the experimental design, where significantly greater achievement was obtained.

EVALUATION OF PEER ASSISTED LEARNING AND COMPUTER ASSISTED INSTRUCTION AS INDEPENDENT INSTRUCTIONAL SUPPLEMENTS

The experimental protocol thus far evaluated has consisted of both peer interaction teaching and learning in combination with computer-managed drill and practice as an adjunct to the classroom lecture. This PAL/CAI experimental protocol was compared with traditional instructional format of lecture-laboratory. Analysis of post-test scores shows significantly greater achievement for the group receiving the experimental PAL/CAI protocol.

In order to evaluate the singular effectiveness of peer interaction and computerized drill, two additional treatment groups were formed. One group, numbering 21, attended only the peer interaction sessions for a total of six hours. Another group, numbering 19, was excused from the peer sessions and were required to drill and practice at the computer terminal for an accumulated total of 3 hours before the instructional unit post-test.

The instructional unit post-test, identical to the one administered in the combined study, was administered to each of the additional treatment groups. Post-test statistics and variance analysis of mean differences are presented.

Research Hypothesis No. 6

The experimental protocol of PAL + CAI will be significantly more effective in the combined format, such that post-test scores for experimental Groups One and Three receiving the combined treatment will be greater than post-test scores for Groups Five and Six, receiving independent treatments of PAL and CAI.

Summary statistics are provided by Statistics Table Two, which follows, and detailed in Data Tables 13, 14, 15, 16 and 17 in Appendix K.

STATISTICS TABLE TWO

Comparison of Post-test Scores for Groups Receiving the Usual Instruction (Control) and Groups Receiving the Experimental CAI/PAL Protocol in the Combined and Individual Format

	Student Number	Post-Test Mean Score	Standard Deviation
Traditional Instruction	23	73.3 ± 6.15	15.04
Lecture with CAI and PAL	31	83.9 ± 3.66	10.40
Lecture with CAI	19	71.6 ± 3.78	8.42
Lecture with PAL	21	73.9 ± 2.54	5.95

VARIANCE ANALYSIS OF POST-TEST SCORES

	Statistical Comparisons	Total #	Variance	Significance
1.	CAI + PAL Mean = 83.9 x CAI Mean = 71.6	50	94.34	Sig P = < .001
2.	CAI + PAL Mean = 83.9 x PAL Mean = 73.9	52	79.23	Sig P = < .001
3.	Control Mean = 73.3 x CAI Mean = 71.6	42	156.3	NS
4.	Control Mean = 73.3 x PAL Mean = 73.9	44	135.3	NS
5.	CAI Mean = 71.6 x PAL Mean = 73.9	40	52.17	NS
6.	CAI + PAL Mean = 83.9 x Control Mean = 73.3	54	159.8	Sig P = < .001

No significant difference in achievement was found for either of the additional experimental groups (Comparison No. 3 and No. 4) where the PAL and CAI were independently provided. In the combined form of PAL and CAI, significantly greater achievement was found compared to the usual traditional lecture-laboratory format (Comparison No. 6). The post-test performance for the PAL group and the CAI group was statistically similar (Comparison No. 5). The PAL and CAI groups separately failed to provide comparable achievement as when administered in the combined form (Comparison No. 1 and No. 2).

This study would support significant achievement for PAL and CAI only in combined form. Independently, achievement is no greater than that of the control group receiving the usual instruction.

EVALUATION OF STUDY TIME AS A FUNCTION OF INSTRUCTIONAL PROTOCOL

In order to compare the time required for examination preparation, participants in this research were requested to record their study time. Both the control group, receiving the usual instruction of lecture-laboratory, and the treatment group receiving the experimental protocol of lecture augmented with Peer Assisted Learning Sessions and Computer Managed Drill and Practice, recorded their study time outside of the assigned class period. The students realized that their records were in no way related to their test scores. Their voluntary participation and accuracy was requested.

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Each student submitted their estimate of study time along with their post-test examinations.

Research Hypothesis No. 7

The average examination preparation or study time will be significantly less for experimental Groups One and Three than for control Groups Two and Four.

Research Findings:

Control Groups	Mean Study Time	=	4.33 Hours
Experimental Groups	Mean Study Time	=	2.98 Hours

F Value = 17.7; Critical F = 3.94
Variance of Means significant, $P = < .001$
See Data Table Eleven, Appendix K

Variance analysis of these mean scores in Data Table Eleven, Appendix K, shows the observed differences to be highly significant, with the experimental group requiring significantly less time to prepare for the instructional unit examination.

This proven feature of CAI, namely more efficient learning rates, is consistent with other studies where increased learning rates are observed without necessarily greater concomitant achievement.

EVALUATION OF SPELLING ACCURACY AS A FUNCTION OF EXPERIMENTAL PROTOCOL

The pre and post-tests for this research consisted of questions requiring the student to write their response. Although the capability for multiple choice questions with computerized scanning and grading was available, such a system makes spelling evaluation difficult. A written student response enables both anatomic accuracy and spelling to be evaluated. The student responses to the pre and post-tests of this research were evaluated for both anatomic and spelling accuracy.

Data of spelling errors for both the control and treatment groups were obtained. The control group of 48 received the usual instruction consisting of lecture with laboratory. The treatment group of 56 received the experimental protocol of lecture augmented with Peer Assisted Learning Sessions and required Computer Managed Drill and Practice.

The peer sessions enabled the student to develop correct pronunciation of anatomic terms which would ultimately promote better spelling. The computer-managed drill and practice opportunity challenged the student to respond with correct spelling. The program was purposely selected for correct spelling in order to develop these skills.

The Drill and Practice Program could be modified to allow acceptable misspelling; however, such an alteration would invalidate one important feature of computer interaction, namely the requirement of precise spelling, grammar, and syntax. Commonly used synonyms, plurals and hyphenations were allowed, but such variance was minimized by having the question call for terminology found in the course material.

Research Hypothesis No. 8

The mean number of post-test spelling errors will be significantly less for Groups One and Three receiving the experimental PAL + CAI treatment, than for control Groups Two and Four.

Research Findings:

Control Groups   Mean Post-test Spelling Errors = 9.35
Experimental Groups   Mean Post-test Spelling Errors = 6.64

F Value = 19.5; Critical F = 3.94
Variance of Means significant, P = $<$ .001
See Data Table Twelve, Appendix K

Clearly, computer usage with its concomitant demands for correct spelling results in substantial improvement. In a subject area where spelling accuracy is a desirable objective, computerized drill and practice provides a most efficient and effective study aid. Certainly a human tutor would not have the patience and infatigability inherent in a computer-managed system. Anatomy, Physiology and Medical Terminology are indeed subject areas where spelling accuracy is very desirable, and spelling skills are often part of the expected and evaluated behaviors in undergraduate courses. An endorsement of computer efficiency is assured, especially when knowledge, achievement and spelling both show significant gains as a result of computer interaction.

The generalizability of this observation to other subject areas where spelling accuracy is also a desirable instructural goal, would seem quite apparent.

EVALUATION OF SIX MONTH RETENTION AS A FUNCTION OF INSTRUCTIONAL PROTOCOL

The successful memorization and recall of anatomic detail requires that the student practice and review the new material repeatedly. Numberous retention studies have shown that recall is enhanced when the student can perceive the meaningfulness and applicability of the material being studied. In order to improve the level of learning anatomic detail, the instructor is compelled to demonstrate associations, explain terminology origins, and in general raise the learning task up from meer rote. Research shows there to be marked forgetting of rote learned material where meaningfulness and relevance are obscure. If the level of learning is sufficiently intense, where the student can clearly identify the applicability of the subject matter, then greater retention and recall should result. Other things being equal, the intensity of learning is often related to the amount of practice and repetitive drill.

Students receiving the traditional or usual instruction program and students of the experimental group which received instruction augmented with peer interaction sessions and computer-managed drill and practice, were pretested, post-tested, and repost-tested six months later. From the mean scores, the percent of retention was computed as:

$$\begin{matrix}\text{Percent}\\\text{Retention}\end{matrix} = \left(\begin{matrix}\text{Re-test}\\\text{Score}\end{matrix} - \begin{matrix}\text{Pretest}\\\text{Score}\end{matrix}\right) \div \left(\begin{matrix}\text{Post-test}\\\text{Score}\end{matrix} - \begin{matrix}\text{Pretest}\\\text{Score}\end{matrix}\right)$$

Research Hypothesis No. 9

Six month retention as measured by repost-testing will be significantly greater for Groups One and Three receiving the experimental PAL and CAI treatment, than for control Groups Two and Four.

Research Findings:

	Mean Pre-test Score	Mean Post-Test Score	Six Months Later	Percent Retention
Control Group Traditional Instruction	60.1 $\pm$ 9.46	76.1 $\pm$ 4.32	67 $\pm$ 5.13	43% *
Experimental Group PAL and CAI	61.6 $\pm$ 5.93	85.4 $\pm$ 2.94	71 $\pm$ 4.86	39% *

*No Significant Difference

No significant difference in retention was found between the two groups. The small retention percentages is consistent with similar studies. Tyler (1933) reported a 22.5% retention of anatomic detail in a zoology course following fifteen months. ("Permanence of Learning," Tyler, R. W., Journal of Higher Education 4:203-204, 1933). McDougall (1958) reports a 72.6% retention for knowledge of facts in an Educational Psychology course after only a four-month interval. ("Differential Retention of Course Outcomes in Educational Psychology," McDougall, W. S., Journal of Educational Psychology, 49:53-60, 1958).

It appears that the degree of retention may depend on the intensity of initial learning as well as activities pursued during the retentional interval. For instance, the students in this retention study, continued as full-time students during the retention interval. During this six-month interval subsequent related material may have had a reinforcing influence on eventual retention.

EVALUATION OF STUDENT ATTITUDES TOWARD THE EXPERIMENTAL PROTOCOL OF PEER ASSISTED LEARNING AND COMPUTER ASSISTED INSTRUCTION

Following post-testing, students receiving the experimental protocol either in combined (PAL and CAI) form or independently (PAL or CAI) were asked to complete a two-part questionnaire. Part One of the questionnaire consisted of fifteen items for PAL evaluation and twenty-one items for CAI evaluation (see Appendixes H, I, and J). The five-point weighted response of students was evaluated. The questionnaire was designed so that the possible range of student response was from 1 - most favorable attitude, to 5 - least favorable attitude. The mean response within this range was computed for each questionnaire item as well as for the entire questionnaire (see Data Tables Eighteen and Nineteen, Appendix K).

Research Hypothesis No. 10

Students receiving the experimental protocol of PAL + CAI will report a favorable attitude for this instructional strategy.

In order to obtain additional individual response, Part Two of the administered questionnaire consisted of open-ended inquiries as to which aspects of the experimental protocol students liked best and least (see Appendix H). A representative sampling of student comment follows.

Questionnaire Item One: "What did you like BEST about the peer teaching and learning sessions?"

"it's new; refreshing departure from the usual classroom activities"

"being student-managed, the pressure of teacher presence wasn't there"

"it was fun, doing something for a change; rather than just listening"

"seeing the mistakes of others made it easier for me to accept my own weaknesses"

"gave us a chance to practice teaching"

"anything's better than just sitting and taking notes"

"we get to know each other and learn from each other"

Questionnaire Item Two: "What did you like LEAST about the peer teaching and learning sessions?"

"one or two people just dominated everyone else"

"it was difficult making yourself understood when explaining the lesson"

"too much pressure and tension from others in the group"

"you can't teach it if you don't know anything"

"I don't like talking in front of groups"

"it was too embarrassing"

Questionnaire Item Three: "What would you recommend to improve the peer teaching and learning sessions?"

"allow more preparation time, perhaps 1-2 days"

"match students together so that the dominant types aren't in the same group"

"provide other options for those unable or unwilling to participate in group activities"

"experiment with somebody else"

"expand this form of teaching, especially for those, like myself, interested in becoming teachers"

"have students choose the group they want to be in"

Questionnaire Item Four: "What did you like BEST about the computer drill and practice sessions?"

"being able to schedule whenever you have time"

"not being afraid of making mistakes; except when it affected my computer score"

"the computer was fun and helpful but at times I felt that it was as dumb as me, because it wouldn't take my answer"

"I liked the immediate grading of answers, so that you knew quickly if your answer was right"

"I liked being able to go to the computer room as many times as I wanted"

"it was new and different"

"I liked having the typed pages to take home for study"

Questionnaire Item Five: "What did you like LEAST about the computer drill and practice sessions "

"sometimes it would disconnect you and then I'd have to start over"

"the computer wouldn't tell you why your answer was wrong. Some I thought were right, but it said NO"

"it was really a waste time if you hadn't studied first. It doesn't teach"

"I found that if you only have a slight error it was counted wrong. I typed 'nerves' and the answer was 'nerve.' Because it said I was wrong, I had to look it up to see what the right answer was"

"I wished that we would have had more time to practice before the test"

Questionnaire Item Six: "What are some recommendations you have to improve the computer drill and practice sessions?"

"let the computer give the correct answers if a student misses one"

"Delta needs more terminals so that more students could use them during the school hours"

"have the computer at least tell you if your spelling was right" "have the same group from class go to the computer room together and drill as a team"

"program the computer to teach as well as drill and practice"

"suggest to other teachers that they use computers in their courses"

In general, the student response was encouraging and from some, very enthusiastic. It appears that their weakness in the area of communication poses some difficulty with peer interaction. The extremely potent force of peer pressure for cooperative participation resulted in psychological difficulties for some, who chose to withdraw or transfer. Fortunately, the number of individuals with this problem was very small.

There was concern that enthusiasm for computer assistance was largely related to its novelty. However, subsequent applications of computerized drill and practice received the same receptive evaluation which would support an expansion of the program. Although students frequently requested that correct answers appear following the student's incorrect response, it was felt that not having the answer printed would serve to encourage the student to review texts, notes or other reference material, and in so doing, the student would develop the skills required to research the correct answer. To have the question and answer printed would make the student too dependent on computerized "spoon feeding" and tend to suppress motivation and individual resourcefulness. The program did permit the student to reexamine any question previously missed which would allow for a new spelling or a different reply to be evaluated. Since the total interaction between student and computer is printed on paper that may be removed by the student, each print-out becomes a very useful study aid.

STUDENT OPINION TOWARD PEER ASSISTED LEARNING

The five-choice option provided by the fifteen-item questionnaire was designed so that a choice of one to each item represented a very favorable attitude for PAL. Conversely, the selection of the fifth response represented the least favorable attitude for Peer Assisted Learning (see Data Table Eighteen, Appendix K).

The overall questionnaire mean response was 2.62 for the range one to five. This relationship might be illustrated thusly.

1..........2..	..........3..........	4..........5
Most Favorable Attitude	Uncertain	Least Favorable Attitude

Research Findings:

	Questionnaire Item	Mean Response
1.	The PAL sessions challenged me to do my best work.	2.13
2.	I found the PAL sessions embarrassing and uncomfortable.	1.66
3.	I would prefer the usual classroom teaching and learning format.	3.03
4.	Having to teach fellow classmates enabled me to learn more effectively.	2.91
5.	Peer teaching was an inefficient use of class time.	1.99
6.	Classmate assistance with study and learning would have resulted without the formal program.	3.35

	Questionnaire Item	Mean Response
7.	I felt capable of teaching my material to fellow classmates.	2.30
8.	The assigned time for the Peer sessions was adequate.	3.00
9.	I would recommend the use of Peer Teaching for other courses.	2.56
10.	Individual personality differences made cooperation awkward.	2.98
11.	I found it difficult to explain scientific concepts to fellow classmates.	3.04
12.	It was especially difficult to make myself understood.	2.91
13.	I would enroll in additional anatomy classes where PAL was being used.	2.90
14.	I particularly enjoy the involvement and participation afforded by the PAL sessions.	2.03
15.	I would prefer to have all of the teaching done by the instructor.	2.57

OVERALL QUESTIONNAIRE MEAN: 2.62

An item-by-item analysis identifies areas of student enthusiasm and areas of student concern. Students appeared receptive to the departure from the traditional format (Items 5 and 14), but appear reserved about any permanent change in strategy (Items 3, 9, 13 and 15). The students viewed teaching and learning effectiveness for the PAL sessions with mixed reactions (Items 1 and 4). While most felt that peer interaction compelled their best effort (Item 1); many were uncertain as to its effectiveness (Item 4). The response to Item 4 calls for a comparison by the student and the consensus of a noncommitted response (Mean Response = 2.91) may well reflect their inability to make such a comparison. Most students were receptive to the participatory aspects of PAL (Item 14) and did not find that their active involvement and exposure produced apprehension (Item 2). Half of the respondents felt that peer assistance and associations would have resulted as part of usual student classroom activities and interaction (Item 6). Group concerns for time allowances (Item 8), personality discord (Item 10) and communication difficulties (Items 11 and 12) appeared to have been manageable even though individual differences were evident.

In summary, student reaction appeared conservatively favorable (Overall Mean Response = 2.62) toward the peer mediated teaching and learning experience. Their cautious optimism would encourage the continual exploration of this teaching strategy.

STUDENT OPINION TOWARD COMPUTER ASSISTED INSTRUCTION

A questionnaire to solicit student attitudes toward the computer interaction sessions was administered to all students participating in and completing the required three-hour computer-managed drill and practice sessions. The total number of questionnaires distributed and evaluated was sixty-five.

The questionnaire was designed in such a manner that favorable responses for CAI were found as first and second choices. The attitude most favorable for CAI would be in the first position, for each item and conversely the least favorable attitude was the last and fifth possible item response.

Attitudinal Questionnaire Item

1	2	3	4	5
Most Favorable Attitude		Uncertain		Least Favorable Attitude

Such a design enables quantification of student response and statistical analysis. A mean response value near 1.0 would reflect a consensus of favorable agreement with the attidues presented by questionnaire item (see Date Table Nineteen, Appendix K).

<u>Research Findings</u>:

	<u>Questionnaire Item</u>	Mean <u>Response</u>
1.	The method by which I was told whether I had given a right or wrong answer became monotonous.	3.15
2.	I felt challenged to do my best work.	2.55
3.	I felt as if someone were engaged in conversation with me.	2.23
4.	I was more involved in operating the terminal than in understanding the course material.	1.31
5.	The learning was too mechanical.	2.69
6.	I felt as if I had a private tutor.	2.16
7.	The equipment made it difficult to concentrate on the course material.	2.49
8.	Computer assisted instruction, as used in this course, is an inefficient use of the student's time.	2.60
9.	I felt frustrated by the situation.	2.39
10.	I found the computer assisted instruction approach in this course to be inflexible.	3.31

	Questionnaire Item	Mean Response
11.	I was satisfied with what I learned while working with the computer.	2.21
12.	I would prefer computer assisted instruction to traditional instruction.	3.35
13.	Computer assisted instruction is just another step toward depersonalized instruction.	3.13
14.	I was not concerned when I missed a question because nobody was watching me.	3.23
15.	I found myself trying to get through the material rather than trying to learn.	2.59
16.	I felt I could work at my own pace.	2.00
17.	Questions were asked which I felt were not related to the material presented.	2.21
18.	Material which is otherwise boring can be interesting when presented by CAI.	2.80
19.	The CAI material was presented too slowly.	2.97
20.	Computer malfunctions made learning difficult.	3.12
21.	Computer assisted instruction makes it possible for me to learn quickly.	2.26

OVERALL QUESTIONNAIRE MEAN: 2.60

Several items examined student attitudes toward the often heard CAI criticism that computer-managed teaching, and drill/practice in particular, is too mechanized, too impersonal, and without any of the qualities desirably found with "living" tutors. Student responses to Items 3, 6 and 13, would not support this criticism. Most students viewed the computer as a "private tutor," engaged in a private conversation with the user. This rapport is encouraged by programming the CAI lesson to use the student's name and vary the reply message so that the computer becomes as unpredictable as a "living" tutor in its response. While many students do view CAI as another step toward depersonalization of instruction (Item 13), it would appear that such a trend might not be viewed as totally undesirable. Such a "depersonalized" or nontraditional approach allows for self-pacing (Item 16). The competitive or game aspect does challenge the student for their best effort (Item 2), with substantial learning (Item 11). Students were reticent of making errors (Item 14) even though the computer interaction is privately conducted without grading or disclosure of student performance. Again the gaming aspect of the user versus the "machine" challenges the student to perform well.

The technology interface may present some difficulty. The "Drill-Response-Drill" methodology may become monotonous (Item 1). However, the novelty of "Buttons to Push" and "Computer Mystique" does not appear to interfere with interaction (Items 4 and 7). The machine does malfunction on occasion resulting in frustration for all concerned. Students viewed such equipment failures as not being a serious detriment to the instructional process (Item 20), and not an inefficient use of time (Item 8). Most students were not frustrated by CAI (Item 9) and perceived the interaction as a learning experience (Item 15). While the material may have been presented slowly (Item 19), its relevance to the instructional unit was confirmed (Item 17), and most students felt that the CAI presentation of instruction may be more desirable for certain material (Item 18). Interestingly, there was agreement that the CAI sessions enabled the material to be mastered more quickly (Item 21). This finding is in agreement with other studies where faster learning rates prevail even though no significant difference may exist for achievement.

While not an unqualified endorsement for CAI, the questionnaire analysis does suggest a favorable student attitude for the computer drill and practice interaction sessions. (The overall questionnaire mean response was 2.60.) Major strengths are identified as individualization and the private opportunity to be tirelessly tutored without fear of making errors. Major weaknesses relate to the students not wanting to remove the "human" teaching from the instructional delivery. The inevitable equipment problems are a source of frustration and certainly distract from the intended outcomes. Students are conservative in their approval of CAI, and in particular with the extension of its use into other subject areas. It would appear that as long as CAI remains an instructional option which may augment but not replace classroom teaching, students favorably approve.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

Both peer teaching and learning sessions and computer-managed drill and practice sessions appear to be effective instructional strategies; not as a replacement for the classroom teacher but rather supplementary and complimentary to the traditional format. Evidence from the literature, from student achievement records, anecdotal responses from participating students, and especially evidence derived from this controlled and statistically evaluated study would support the finding that CAI and PAL were most effective for this application. Students are eager and most receptive to an instructional strategy that allows them active participation. The passivity of traditional methods tends to stifle independent effort and provide little in the way of individualized instruction. However, the K-12 years of being a passive recipient of pedagogical wisdom has conditioned students to this role. Any abrupt change could create psychological trauma for some. The exposure, the responsibility and the close association required in a peer structured learning experience may create unmanageable difficulties for the individual. Because of these inherent weaknesses, the generalizability of peer learning may well depend more on the expertise, talent and perceptiveness of the instructor rather than documentation that peer teaching is effective.

The common notion of teaching as simply giving information to a class, disregards other very important facets of the task. Such a notion presents a very limited view of the variety of teaching methods and techniques available and of the kinds of behavior changes possible. By and large instructional practices are based on principles from learning theory psychology and when a clear application to teaching is lacking, the teacher must simply resort to the methodology that produces desired results. While it is true that an individual, particularly one that is motivated and bright, can learn without a teacher, his efforts can be quite inefficient. Individuals who need to learn health information and skills, even though they are motivated, often do not have sufficient orientation to health matters to attain the goal alone. It, therefore, becomes encumbered upon the teacher to provide assistance, in whatever form, which will offer to each student the opportunity for success.

In order to maintain motivation and be truly self-directing, an individual must receive satisfaction for learning. The teacher maximizes this by establishing realistic objectives and goals for the student. In addition, by involving the student as an active participant in the educational process, the wise teacher utilizes the creative and expressive talents of the student to bring about a feeling of fulfillment and self-worth for himself. To change the educational setting from one highly competitive to one highly cooperative, is to establish a sense of community and common purpose that encourages learning and personal growth.

An instructional strategy that provides several options for learning can challenge the individual with a varied departure from the passive traditional methods. The pedagogical format becomes truly individualized as each student is offered an instructional option that truly leads to a sense of adequacy. The ideal might be perceived as the college providing a "supermarket" of instructional strategies. Clearly, peer learning and computerized assistance is a movement to this end, where the individualization of instruction is the desired goal; where the acquisition of knowledge has its humane uses such as enabling stimulating interactive discourse, establishing rapport, and the tools for sharing common interests. Allowing students to learn by teaching raises learning from the Knowledge level to the higher level of Application, which offers the student a broad opportunity for self-fulfillment.

The experimental protocol consisting of both peer and computer interaction appears to provide such a substantial level of learning intensity, that minimum additional study time is required. In a very real sense these supplementary sessions (PAL and CAI) constitute both group and individual study sessions, where concepts and detail are tested, verbalized, and drilled. Such an accomplishment is indeed the desired objective of any supplementary exercise that follows the lecture. However, the classical laboratory period of demonstration, experimentation and data gathering often fails to attain the objective of instructional enrichment, but rather becomes merely an appendage of the usual instructural process. Providing answers for an anatomical diagram, labeling of illustrations and similar mechanical exercises, although classical in style, are not always challenging to the student. The tasks are often carried out in a rote and mechanical manner where the intensity of learning is indeed quite shallow.

Learning, retention, and application are known to be correlated with the intensity of the educational experience and its mode of delivery. The active involvement of the student, required in PAL and the individualized drill and practice offered by CAI provides an instructional delivery system that challenges best performance, offers involvement and establishes an intense educational experience.

Because of the rapid increase in school enrollment, the fantastic expansion of knowledge, and the demand by the bill-paying public for economical yet sound educational practices, educational institutions are confronted with a multi-faceted dilemma that requires utilization of new and better teaching techniques. This problem has been a growing one for several decades and the educational specialists have emerged with many interim solutions--everything from the mass lecture to broadcast television--in an attempt to cope with the problem.

Although each medium has its obvious strengths and weaknesses, most are coming under increasing attack by educators who feel that the learning process is not nourished to the extent that it should be. Thus, we too often have a medium that only enables an institution to group hundreds of students and hopefully lower the educational cost. Unfortunately, even though the cost in dollars has been decreased, the wasted student time and the less-than-acceptable learning is a cost that our society cannot afford.

Early attempts at adapting instruction to the needs of the learner resulted in an interim solution known as individual instruction. This instruction merely allowed students to work individually through a programmed text or audio/visual presentation in a lock-step fashion that resulted only in pacing students and not considering individual differences other than speed. On the other hand, individualized instruction suggests that something unique about the learner has been taken into account in a dynamic way to build an instructional sequence.

The simple, yet important act of purveying information is also in dire need of improvement. Lecture halls are sadly lacking; instructional television seems not to be the answer; and the long-time stand-by, the textbook is, in itself, not an acceptable medium to present material to an unmotivated student.

For some time educators have agreed that instruction, if it is to be successful, must not be directed toward a mass of students gathered in some lecture hall.

It is important that new methods and techniques be developed that will improve the quality of instruction and, at the same time, make it available to all students, whether advanced, disadvantaged, or removed physically from centers of learning. We must have available, now, instructional techniques that will provide relief from standard teaching methods and yet have the capacity to include the fast-rising number of students clamoring for education.

The newest technology to appear, and one that promises to open this door to efficient, low cost, and sound education, is computer assisted instruction. Computer assisted instruction (CAI) is just now entering its second decade of development, and so far has shown itself to be a most promising medium for improving the educational process. Because adequate data for evaluation requires time and because the development of techniques and hardware must preceed utilization, the concept is still young and not totally proven. The future, however, seems to be bright.

When one looks at the cost of CAI, he must take into account three areas of potentiality which may affect the probability of acceptance. First is the comparison of CAI to the cost of other modes of instruction. CAI costs per student hour are not as expensive as other modes of instruction such as remedial instruction, vocational instruction, or homebound instruction. Neither is it high when one thinks of allowing the people termed as uneducable to remain so.

Secondly, there is the fact that while the costs of technology required to produce and maintain CAI are steadily decreasing, the costs of conventional education are soaring. The increasing number of personnel and the increasing cost of this staff suggests that schools should very seriously consider modern educational technology as an alternate approach for meeting some of their goals.

The third potentiality is the fact that a computer installed as an instructional tool may well be adapted for administrative duties, e.g., after hours use as a scheduler, grade reporter, bookkeeper, etc. On this basis alone the cost of a CAI system could be justified. It is also this use which helps make the cost of CAI, as an instructional tool, inexpensive.

Using the computer most closely simulates the ideal instructional situation, i.e., a one-to-one relationship between instructor and student, for CAI has the flexibility and capacity for individualizing instruction which is necessary for the adaptive education that a wide variety of learners requires.

There are three fundamental characteristics of computer applications in instruction which suggest that significant steps in improving instruction can be achieved through the utilization of computers. The first characteristic of computer assisted instruction is the active responding by the student. This characteristic is quite important for the slower learner. A properly prepared child may learn by reading through a textbook or other printed material. The unmotivated child simply needs the active response to and the feedback from the computer program.

A second characteristic is the ability of a program in the computer to evaluate the student's responses and provide information regarding these responses. This allows feedback tailored to the ability level of each student, regarding his responses; whether he be the most advanced or the poorest student. It also indicates that the poorest student still received feedback regarding his work at the minimum of once per minute, while in a regular classroom, this same student, governed by his reticence, may respond and receive feedback only two to three times per week. This individual attention and individual responsibility tend to motivate even the most reluctant pupil.

A third feature of the computer's ability as an instructor is its individualization of instruction not only at the level of achievement but in reference to the specific interests and abilities of the student. The computer can keep a record of the student's performance and progress through a course and alter that course based upon the immediate past history of the individual student in studying that subject matter. This dynamic characteristic of CAI makes it possible to begin considering not the passage of time nor the covering of a specific text nor doing a given number of problems as criteria for progressing through the curriculum, but the opportunity to base student assessment upon the mastery of predetermined criterion levels. Thus, each pupil takes a "branching" route through his course with his exact path depending upon his own successes in each stage. No pupil is allowed to persist in practice that is too easy for him or to suffer repeated failure in lessons that are too difficult.

An important side advantage of using the computer is its ability to keep the teacher constantly informed of the progress being made by each student. At the same time, besides informing the teacher of the progress of each pupil, the system also has the capacity to deliver periodic reports on the progress of the class as a whole, thus enabling the teacher to make necessary changes in her plans, methods, etc.

Invariably, when one begins to speak of a new or an improved technology to aid the educational process, an outcry arises relative to what this innovation will do to the status of the present teacher. Some believe that a newer technology, such as CAI, is a "flash-in-the-pan" and will die out if left alone. Others become upset because of fear that they will be replaced by a computer, and their defense mechanism puts forth arguments to school boards that are often quite convincing.

In actual experience to date, it has been seen quite clearly that the computer and CAI do not replace the present teacher, but merely rearranges teacher priorities. With CAI handling drill and recitation, the teacher can do what a teacher does best: develop new concepts. CAI will take away the drudgery of rote teaching; a consistently endless time and energy draining technique. It is during this time that the teacher is freed to act as diagnostician; to help individuals with problems. Also, the computer, used as an administrative tool, will virtually eliminate the teacher's acting as a human data processing machine, i.e., inventorying, grading papers, counting heads, scheduling, etc. This technology allows teachers to concentrate their attention on the personally human concerns of their students. Teachers can spend time on the higher order activities of motivating pupils, diagnosing learning handicaps of individuals, and prescribing appropriate and effective remedial instruction. Released from their normal repetitive tasks, they can now facilitate such activities as group meetings in which students discuss their hopes, fears, dreams, and anxieties. Teachers can help students in their struggle to resolve value issues and conflicts and overcome feelings of alienation, powerlessness and self-doubt. Teachers can help students set meaningful goals, order their priorities and make important personal and social decisions.

One of the strongest educational features of the computer, is its ability to provide tireless drill and immediate evaluation. Its demand for precision in spelling as well as factual accuracy, makes computer augmented instruction in anatomy most appropriate.

Computerized drill and practice must be viewed as an instructional aid, supplemental to the educational process. This particular computer mode is not designed to be the major instructional delivery system. Its published record for achievement is significant.

Only when used as an adjunct to classroom teaching rather than constitute the major instructional delivery system is post-test achievement found to be significant. While post-test achievement for the group participating in computerized drill and practice is not significantly greater than achievement for the control group, the important factors of study time, instructional time, and supply and equipment requirements must also be considered.

The laboratory periods that are traditionally supplemental to the formal lecture, are designed to provide enrichment and instructional reinforcement, where opportunities for individual, personalized tutorlage is a prime objective. Tutorlage in this setting is invariably instructor mediated and as such, introduces the significant weakness of this delivery system. The instructor is physically unable to personally tutor, drill, and interact with each class member as individuals. While computer assistance and peer teaching independently may not provide additional achievement on post-test scores, the merger of an instructional system, where individual "active" participation is required and automated drill and practice is encouraged, offers the most significant achievement in the shortest time frame. Examination scores and similar measures of achievement fail to evaluate secondary outcomes and learning qualities that are often more affective than cognitive.

The attitudinal data provided by students which appears in this document reveals an acceptance for the experimental design not entirely related to better performance on instructional post-tests.

It seems obvious that one would expect that student attitude toward the method of instruction will play an important role in both the acquisition of and the transfer of learning. A student with a more favorable attitude will probably be inclined to learn more and to apply what he has learned to other situations.

Because PAL/CAI is what one would consider a new and different learning environment, it is important to determine what the attitude of participating students is toward the medium.

Several studies to date indicate an overwhelming preference for CAI instruction over traditional courses primarily because of the convenience of this method and the constant interaction in the learning process. Attitudinal data is also valuable in gauging improvements to the course content, the instruction, and the media.

The attitudinal responses reported in this thesis, while favorable, were obtained in such an independent and individual manner (i.e. CAI groups and PAL groups were not presented with the same evaluation instrument) that attitudinal inferences and comparisons between groups would not be valid. However, as discrete reports of student opinion, one may validly interpret a favorable student attitude for each of the independent strategies.

It must be remembered, however, that although preliminary information is favorable, adequate data will not be available until students have been exposed to CAI over a number of years in varying subject matter.

<u>Recommendation for future study would include the following considerations:</u>

a) To what extent were the achievement gains documented related to the experimental population being 90% women?

b) Could computer lessons effectively prepare the student for an in-class, Peer Assisted Learning role?

c) To what extent was the success of this study and its subsequent generalization related to the enthusiasm and charismic influence of the experimentor?

d) Could student involvement beneficially extend beyond peer teaching to peer evaluation and testing?

e) Would a teaching design that allowed and encouraged the students to develop and actually program computer lessons, provide a worthwhile learning environment?

The educational challenge of the seventies which cries out for instructional individualization, must be met with response, research and renewal; not apathy and the continuance of past practices.

Of course, the amount of teaching theoretically possible in a school is limited by the number of students and by the teacher's ingenuity in providing mass education. Teaching is easy when the learner is dealing directly with materials or events, in which the teacher assumes the role of coordinator, manager or resource person. On the other hand, teaching is very difficult when the learner must deal mostly with the teacher and only through the teacher for instructional opportunities. There is much evidence that the teacher could be effectively and efficiently assisted by employing peer group and computerized learning.

APPENDICES

APPENDIX A

APPENDIX A

OSTEOLOGY PRE-TEST

1. Identify the long bone of the thigh. ______________
2. Identify the larger of the lower leg bones. ______________
3. Identify the group of 7 bones that form the ankle. ______________
4. Identify the group of 5 bones found in the palm of the foot. ______________
5. Identify the long bone of the upper arm. ______________
6. Bone cells are termed. ______________
7. A break in cartilage or bone is termed. ______________
8. Identify the group of 8 bones that forms the wrist. ______________
9. Identify the group of 5 bones found in the palm of the hand. ______________
10. Identify the scientific name for the collarbone. ______________
11. The bones of the neck are known as . . . . . vertebrae. ______________
12. The vertebrae that attaches to the skull is designated. ______________
13. The largest of the three hip bones is termed. ______________
14. Identify the term for the lower jaw. ______________
15. Identify the term for the upper jaw. ______________

APPENDIX A (continued)

16. Bones of the upper and lower extremity comprise the . . . . . skeleton. ____________

17. Bones of the skull, vertebrae, ribs, sternum, and hyoid comprise the . . . . skeleton. ____________

18. The shaft of a typical long bone is termed. ____________

19. The skull bone which forms the forehead is termed. ____________

20. The skull bone which contains the ear passage is termed. ____________

APPENDIX B

APPENDIX B

OSTEOLOGY POST-TEST

1. Identify the larger of the lower leg bones. ________________

2. The microscopic arrangement of bone cells and canals is known as the . . . system. _______ _______

3. Identify the group of 7 bones that form the ankle. ________________

4. Identify the group of bones found in each toe (two for the great toe.) ________________

5. Identify the term for the blood forming function of bones. ________________

6. Identify the scientific name for the shoulder blade. ___ ____________

7. Ribs that attach directly to the sternum are termed. ________ ______

8. The five vertebrae of the lower back are termed. ____ __________

9. Name the largest of the sesamoid bones. ________________

10. Identify the bone at the base of the skull which contains the large foramen magnum. ________________

11. The cheek bone of the skull is termed. __ _____________

12. The skull bone which contains the ear passage is termed. ____ __________

13. The so called soft spots of the skull where ossification is incomplete are termed. ________________

APPENDIX B (continued)

14. The ossification process that forms the bones of the body except skull and face bones is termed. ________________

15. A multiple break in bone or cartilage is termed. (Two words) ________________

16. Spongy or lacy appearing bone is termed . . . . . . bone. ________________

17. Since the second cervical vertebrae pivots on the first cervical vertebrae, this C2 vertebrae could be termed. ________________

18. The shaft of long bones is termed. ________________

19. The connective tissue sheath which covers the bone is termed. ________________

20. The osteopathology that results in demineralization of the mature bony matrix is termed. ________________

Identify the bone that has the listed feature.

21. Supraorbital notch ________________

22. Sella Turcica ________________

23. Carotid and Jugular Foramina ________________

24. Acromion Process ________________

25. Medial Epicondyle ________________

26. Foramen Magnum ________________

27. Xiphoid Process ________________

28. Olecranon Process ________________

29. Acetabulum ________________

30. Superior and Middle Turbinates ________________

31. Obturator Foramen ________________

APPENDIX B (continued)

32. Trochanter ____________

33. Mental Foramina ____________

34. Medial Malleolus ____________

35. Lateral Malleolus ____________

APPENDIX C

APPENDIX C

SKELETAL SYSTEM

INSTRUCTIONAL OUTLINE

A. Function

1. Support
2. Protection
3. Movement
4. Hemopoiesis
5. Calcium Storage

B. Types

1. Cancellous (spongy)
2. Compact (dense)

C. Shapes

1. Long (humerus)
2. Short (carpals)
3. Flat (ribs)
4. Irregular (vertebrae)
5. Sesamoid (patella)

D. Classification

1. Axial: skull, vertebrae, ribs, sternum
2. Appendicular: upper and lower extremities

E. Gross Anatomy of a Long Bone

1. Diaphysis
2. Epiphysis
3. Articular cartilage (hyaline)
4. Periosteum
5. Medullary cavity
6. Traveculae
7. Epiphyseal plate
8. Compact bone
9. Cancellous bone

APPENDIX C (continued)

F. Bone Markings

1. Depressions and openings
   a. fossa
   b. sinus
   c. foramen
   d. meatus
2. Projections and protuberances
   a. Condyle
   b. Head
   c. Trochanter
   d. Crest
   e. Spinous process
   f. Tuberosity
   g. Tubercle

G. Osteogenesis

1. Intramembranous (face and skull bones)
2. Endochondral osteogenesis

H. Compact Bone Histology

1. Haversian system
   a. Lamellae
   b. Lacuma
   c. Canaliculi
   d. Haversian canal
   e. Osteocyte
   f. Volkmann's canals

I. Types of Fractures

1. Fatique
2. Pathologic
3. Longitudinal
4. Spiral
5. Compression
6. Greenstick
7. Simple
8. Compound
9. Comminuted
10. Transverse

APPENDIX C (continued)

J. Fracture Repair

1. Hematoma production
2. Granulation development
3. Callus growth
4. Ossification via periosteum

K. Osteopathology

1. Rickets
2. Osteomalacia
3. Osteoporosis
    a. Postmenopausal
    b. Disuse
    c. Ca++ deficiency
    d. Idiopathic
4. Osteomyelitis
5. Osteogenic sarcoma
6. Scoliosis
7. Kyphosis
8. Lordosis

L. Axial-Skull and Vertebrae

1. Frontal
    a. Frontal Sinuses
    b. Supraorbital notch (sometime foramen)
2. Zygomatic
3. Temporal
    a. Mastoid process
    b. External auditory meatus (canal)
    c. Zygomatic process
    d. Internal auditory meatus
    e. Mandibular fossa
    f. Styloid process
    g. Stylomastoid foramen
    h. Carotid canal or foramen
    I. Jugular foramen and fossa
4. Occipital
    a. Foramen magnum
    b. Condyles
5. Sphenoid
    a. Sella turcica, or Turk's saddle
    b. Optic foramen
    c. Superior orbital fissure
    d. Foramen rotundum
    e. Foramen ovale

APPENDIX C (continued)

6. Ethmoid
    a. Perpendicular plate
    b. Horizontal (cribiform)
    c. Superior and middle turbinates (conchae)
7. Mandible
    a. Body
    b. Ramus
    c. Condyle (or head)
    d. Alveolar process
    e. Mandibular foramen
    f. Mental foramen
8. Maxilla
    a. Alveolar process
    b. Palatine process
    c. Infraorbital foramen
    d. Lacrimal groove
9. Palatine - Horizontal plate
10. Parietal
11. Nasal
12. Vomer
13. Special features of skull
    a. Sutures
        (1) Sagittal
        (2) Coronal
        (3) Lambdoidal
        (4) Squamosal
    b. Fontanels
    c. Sinuses - Air (or bony)
14. Bones of the thorax
    a. Sternum
        (1) Body
        (2) Manubrium
        (3) Xiphoid process
    b. True ribs (7 pairs)
    c. False ribs (3 pairs)
    d. Floating ribs (2 pairs)
    e. Costal cartilage
    f. Costal facets

M. Appendicular

1. Bone Anatomy - general considerations
    a. There are four types of bones
        (1) Long bones (humerus, femur)
        (2) Short bones (wrist and ankle)
        (3) Flat bones (ribs, skull top, hip)
        (4) Irregular bones (vertebra, jaw)

APPENDIX C (continued)

b. Bones have markings
    (1) Depressions and openings
        (a) Fossa (depression)
        (b) Sinus (cavity)
        (c) Foramen (hole)
        (d) Meatus (tube-like)
    (2) Protuberances or processes
        (a) Condyle (joint surface)
        (b) Head (joint surface)
        (c) Trochanter (large prominance)
        (d) Tuberosity (smaller prominance)
        (e) Tubercle (smallest prominance)
c. Bones have anatomical regions
    (1) Diaphysis (shaftlike portion)
    (2) Epiphysis (bulbous joint end)

2. Appendicular skeleton
    a. Bones of the shoulder girdle and upper extremity
        (1) Scapula
            (a) Glenoid fossa
            (b) Scapula spine
            (c) Acromion process
            (d) Coracoid process
        (2) Clavicle - sternoclavicular joint
        (3) Humerus
            (a) Head
            (b) Greater tuberosity
            (c) Lesser tuberosity
            (d) Deltoid tubercle
            (e) Olecranon fossa
            (f) Medial epicondyle
            (g) Trochlea and capitulum
            (h) Bicipital groove
            (i) Coronoid fossa
        (4) Ulna
            (a) Olecranon process
            (b) Coronoid process
            (c) Styloid process
            (d) Head
        (5) Radius
            (a) Head
            (b) Neck
            (c) Styloid process
            (d) Radial tuberosity (bicipital)
        (6) Carpals (8)
        (7) Metacarpals (5)
        (8) Phalanges manus (14)

APPENDIX C (continued)

b. Bones of the pelvic girdle and lower extremity
- (1) Hip bone
  - (a) Ilium
    - Iliac crest
    - Acetabulum
    - Sciatic notch
  - (b) Pubis
    - Pubic symphysis
    - Pubic angle
  - (c) Ischium
    - Ischial spine
    - Obturator foramen
    - Ischial tuberosity
- (2) Femur
  - (a) Head
  - (b) Neck
  - (c) Greater trochanter
  - (d) Lesser trochanter
  - (e) Lateral condyle
  - (f) Medial condyle
  - (g) Adductor tubercle
  - (h) Lateral epicondyle
  - (i) Patella
  - (j) Popliteal surface
- (3) Tibia
  - (a) Lateral condyle
  - (b) Medial condyle
  - (c) Medial malleolus
  - (d) Fibula facet
  - (e) Tibial tuberosity
- (4) Fibula
  - (a) Head facet
  - (b) Lateral malleolus
  - (c) Talus socket
- (5) Tarsals (7)
  - (a) Talus
  - (b) Calcaneum
- (6) Metatarsals (5)
- (7) Phalanges pedis (14)

APPENDIX D

APPENDIX D

OBJECTIVES AND STUDY GUIDE

OSTEOLOGY

A student's level of mastery for these stated goals will be determined by his ability to correctly answer a series of test questions which sample these behaviors. Each of the following statements can be prefaced with the phrase, "The student should be able to".

1. After defining the skeletal system, list and describe its five primary functions.

2. Describe the classification of bones <u>by shape</u> and give samples of each of these bone types:
   a. long
   b. short
   c. flat
   d. irregular
   e. sesamoid

3. Given a longitudinally sectioned bone or a diagram of a longitudinally sectioned bone identify each of the parts listed below.
   a. epiphysis
   b. diaphysis
   c. epiphyseal plate or line
   d. periosteum
   e. medullary (marrow) cavity
   f. articular surface
   g. endosteum
   h. compact bone
   i. spongy (cancellous) bone

4. Draw and identify on a diagram or model these components of a Haversian system seen in a section of compact bone:
   a. Haversian canal
   b. Haversian canal contents
   c. concentric lamellae

APPENDIX D (continued)

d. canaliculi
e. lacunae
f. Volkmann's canals
g. osteocytes

5. List and describe the three connective tissue components of bone tissue.

6. Distinguish between endochondral (cartilaginous) and intramembranous ossification in the embryo and relate these processes to the longitudinal and diameter growth of bone following birth.

7. Define each of the following and then compare and contrast them in terms of their function and location:
   a. osteocyte
   b. osteoblast
   c. osteoclast

8. When given a diagrammatic representation of an anterior and posterior view of the human skeleton, distinguish between the components of the axial and appendicular divisions of the skeleton, by marking them in some way (e.g. shading or labeling).

9. When given a diagrammatic representation of an anterior and posterior view of a human skeleton or an adult human skeleton, identify each of the following bones and bony landmarks; also describe the distinguishing characteristics of each bone:
   a. Clavicle
   b. Scapula
      (1) spine
      (2) acromian process
      (3) coracoid process
      (4) supraglenoid tuberosity
      (5) supraspinous fossa
      (6) infraspinous fossa
      (7) inferior angle
      (8) superior angle
      (9) medial border
      (10) lateral border
      (11) glenoid cavity
   c. Humerus
      (1) head
      (2) greater tubercle

APPENDIX D (continued)

(3) lesser tubercle
(4) deltoid tuberosity
(5) trochlea
(6) capitulum
(7) medial epicondyle
(8) lateral epicondyle
(9) olecranon fossa

d. Radius
(1) radial tuberosity
(2) styloid process

e. Ulna
(1) olecranon process
(2) ulnar tuberosity
(3) styloid process
(4) coronoid process

f. Carpal bones
(1) pisiform bone

g. Metacarpal bones

h. Phalanges (thumb and fingers)

i. Hip bone
(1) acetabulum
(2) iliac crest
(3) ischial tuberosity
(4) obturator foramen
(5) iliac fossa
(6) anterior superior iliac spine
(7) anterior inferior iliac spine
(8) superior pubic ramus
(9) ischiopubic ramus

j. Femur
(1) head
(2) greater trochanter
(3) lesser trochanter
(4) medical fracture
(5) medial condyle
(6) lateral condyle
(7) medial supracondylar ridge
(8) lateral supracondylar ridge
(9) linea aspera

k. Patella

l. Tibia
(1) tibial tuberosity
(2) medial malleolus
(3) medial condyle
(4) lateral condyle
(5) 3 surfaces of the tibia (medial, lateral and posterior)

APPENDIX D (continued)

m. Fibula
   (1) head
   (2) lateral malleolus
n. Tarsals
   (1) talus
   (2) calcaneus
o. Metatarsals
p. Phalanges (toes)

10. When given a series of diagrammatic representations of the anterior, superior, inferior, internal floor and lateral aspects of the skull, correctly identify and label the following bones, classify each as a paired or unpaired bone of the cranium (neurocranium) or face (viscerocranium), classify each according to its shape, describe the distinguishing characteristics of each, and when possible, palpate the:
    a. occipital
    b. parietal
    c. frontal
    d. temporal
    e. sphenoid
    f. ethmoid
    g. nasal
    h. lacrimal
    i. maxilla
    j. zygomatic
    k. mandible
    l. palatine
    m. vomer
    n. inferior concha (turbinate)

11. State the location of these specialized bones of the skull:
    a. auditory ossicles (malleus, incus and stapes)
    b. sutural (Wormian) bones
    c. hyoid bone

12. Define the word suture and describe the location of these specific examples:
    a. coronal suture
    b. sagittal suture
    c. lambdoidal suture

APPENDIX D (continued)

13. Define the word fontanel and state its function and/or when given a diagrammatic representation of the superior and lateral aspects of the fetal skull, correctly identify and label the:
    a. anterior fontanel
    b. posterior fontanel
    c. sphenoidal (anterolateral) fontanel
    d. mastoid (posterolateral) fontanel

14. Given a diagram of the anterior and posterior skeleton or a human skeleton correctly identify these components of the axial skeleton:
    a. cervical vertebrae
    b. thoracic vertebrae
    c. lumbar vertebrae
    d. sacrum
    e. coccyx
    f. sternum (manubrium, body and xiphoid process)
    g. ribs

15. Given a diagrammatic representation of the superior and lateral aspects of a "typical vertebra" or a real thoracic vertebra correctly identify the:
    a. body
    b. neural arch
    c. pedicle
    d. lamina
    e. transverse process
    f. vertebral foramen
    g. spinous process
    h. superior articulating process
    i. inferior articulating process

16. Describe and discuss the relative size and distinguishing characteristics of the following components of the spine (vertebral column):
    a. cervical vertebrae
        (1) atlas or C-1
        (2) axis or C-2
    b. thoracic vertebrae
    c. lumbar vertebrae
    d. sacrum
    e. coccyx

APPENDIX E

APPENDIX E

COMPUTER PROGRAM IN BASIC
THE SKELETAL SYSTEM

ANAT-2

```
5 LET W=0
10 PRINT
11 PRINT
12 PRINT
13 PRINT
14 LET Q=0
15 LET W=0
50 PRINT"THIS PROGRAM IS DESIGNED TO PROVIDE DRILL AND PRACTICE IN THE AREA
51 PRINT"                              HUMAN ANATOMY%
52 PRINT
53 PRINT
54 PRINT
55 PRINT "          INSTRUCTIONAL UNIT TWO :  THE SKELETAL SYSTEM"
56 PRINT
57 PRINT
58 PRINT
59 PRINT "THIS PROGRAM MAY BE USED AS A PRETEST,POST-TEST OR FOR"
60 PRINT "TUTORIAL DRILL AND PRACTICE.  QUESTIONS ARE RANDOMLY"
61 PRINT "SELECTED FROM A POOL OF 200 ITEMS.  A REPORT OF CORRECT"
62 PRINT "RESPONSES IS CALCULATED AND PRINTED FOLLOWING EACH ANSWER."
63 PRINT "SUMMARY CALCULATIONS ARE PROVIDED WHEN CONCLUDED AND THE "
64 PRINT "OPPORTUNITY FOR RE-EXAMINATION OF ANY ITEM IS AVAILABLE."
65 PRINT
66 PRINT
67 PRINT "REMEMBER, EACH QUESTION MUST BE ANSWERED WITH CORRECT SPELLING"
68 PRINT
69 PRINT
70 PRINT "OKAY, LET'S BEGIN !!"
71 PRINT
72 PRINT "PLEASE TYPE YOUR FIRST NAME";
73 INPUT A1$
74 PRINT "PLEASE TYPE YOUR LAST NAME ";
75 INPUT B1$
76 PRINT "TYPE YOUR INSTRUCTOR'S LAST NAME";
77 INPUT C1$
78 PRINT
79 PRINT
80 PRINT
81 PRINT "THANK YOU,  ";A1$;" YOU ARE 100% CORRECT SO FAR !!! "
82 PRINT
83 PRINT
84 PRINT "NOW ,  FOR THE TOUGH ONES !!"
85 PRINT
86 LET J=0
87 LET W=0
88 RANDOMIZE
89 DIM C(80)
90 LET A=1
91 LET B=81
92 LET X=INT (RND*(B-A)+A)
```

ANAT-2 (CONTINUED)

```
93 IF C(X) <>0 THEN 3000
94 LET Q=Q+1
95 PRINT X
96 IF X>80 THEN 3028
97 LET C(X)=X
98 IF X<=16 THEN 105
99IF X<=32 THEN 106
100 IF X<=48 THEN 108
101 IF X<=64 THEN 110
102 IF X<=80 THEN 112
103
104
105 ON X GOTO 220,260,300,340,380,420,460,500,540,580,630,670,710,750,790,870
106 LET X=X-16
107 ON X GOTO 910,950,990,1030,1070,1110,1150,1190,1230,1270,1310,1350,1390,
440,2030,2080
108 LET X=X-32
109 ON X GOTO 2120,2160,2200,2240,2271,2275,2279,2284,2289,2294,2299,3100,315
200,3250,3290
110 LET X=X-48
111 ON X GOTO 3330,3370,3410,3450,3490,3540,3590,3630,3680,3800,3840,3880,
010,4050,4100,4140
112 LET X=X-64
113 ON X GOTO 4200,4240,4280,4330,4380,4420,4456,4461,4465,4470,4474,4478,
483,4487,4491,4495
114
119
120 PRINT CHR$(ASC(BEL))
121
220PRINT"IDENTIFY THE LONG BONE OF THE THIGH"
230 INPUT A$
240 IF A$="FEMUR"THEN 1480
250 GOTO 1650
260 PRINT"IDENTIFY THE LARGER OF THE LOWER LEG BONES"
270 INPUT B$
280 IF B$="TIBIA"THEN 1480
290 GOTO 1650
300 PRINT"IDENTIFY THE SMALLER OF THE LOWER LEG BONES"
310 INPUT C$
320 IF C$="FIBULA"THEN 1480
330 GOTO 1650
340PRINT"IDENTIFY THE BONE THAT FORMS THE KNEE CAP "
350 INPUT D$
360 IF D$="PATELLA"THEN 1480
370 GOTO 1650
380 PRINT"IDENTIFY THE GROUP OF 7 BONES THAT FORM THE ANKLE"
390 INPUT E$
400 IF E$="TARSALS"THEN 1480
410 GOTO 1650
420PRINT"IDENTIFY THE GROUP OF 5 BONES FOUND IN THE PALM OF THE FOOT"
430 INPUT F$
440 IF F$="METATARSALS"THEN 1480
450 GOTO 1650
460 PRINT"IDENTIFY THE GROUP OF BONES FOUND IN EACH TOE (2 FOR THE GREAT TOE)
```

ANAT-2 (CONTINUED)

```
470 INPUT G$
480 IF G$="PHALANGES"THEN 1480
490 GOTO 1650
500PRINT"IDENTIFY THE LONG BONE OF THE UPPER ARM"
510 INPUT H$
520 IF H$="HUMERUS"THEN 1480
530 GOTO 1650
540 PRINT"IDENTIFY THE BONE OF FOREARM THAT IS IN LINE WITH THE THUMB"
550 INPUT I$
560 IF I$="RADIUS" THEN 1480
570 GOTO 1650
580 PRINT"IDENTIFY THE BONE OF THE FOREARM WHICH IS IN LINE WITH THE THIRD"
590 PRINT"FINGER AND ALSO FORMS THE POINT OF THE ELBOW"
600 INPUT J$
610 IF J$="ULNA" THEN 1480
620 GOTO 1650
630 PRINT "IDENTIFY THE GROUP OF EIGHT BONES THAT FORMS THE WRIST"
640 INPUT K$
650 IF K$="CARPALS" THEN 1480
660 GOTO 1650
670 PRINT "IDENTIFY THE GROUP OF FIVE BONES FOUND IN THE PALM OF THE HAND"
680 INPUT L$
690 IF L$="METACARPALS" THEN 1480
700 GOTO 1650
710PRINT"IDENTIFY THE GROUP OF 5 BONES FOUND IN EACH FINGER (2 FOR THE HAND)"
720 INPUT M$
730 IF M$="PHALANGES"THEN 1480
740 GOTO 1650
750 PRINT"IDENTIFY THE SCIENTIFIC NAME FOR THE COLLARBONE"
760 INPUT N$
770 IF N$="CLAVICLE"THEN 1480
780 GOTO 1650
790PRINT"IDENTIFY THE SCIENTIFIC NAME FOR THE SHOULDER BLADE"
800 INPUT O$
810 IF O$="SCAPULA"THEN 1480
820 GOTO 1650
830 LET A=1
840 LET B=15
870PRINT"RIBS THAT DO NOT ATTACH DIRECTLY TO THE STERNUM ARE TERMED ???"
880 INPUT P$
890 IF P$="FALSE" THEN 1480
900 GOTO 1650
910 PRINT "RIBS THAT ATTACH DIRECTLY TO THE STERNUM ARE TERMED ??"
920 INPUT Q$
930 IF Q$="TRUE" THEN 1480
940 GOTO 1650
950 PRINT "RIBS THAT ONLY ATTACH TO THE VERTEBRAE ARE TERMED ??"
960 INPUT R$
970 IF R$="FLOATING" THEN 1480
980 GOTO 1650
```

ANAT-2 (CONTINUED)

```
990 PRINT "THE SEVEN VERTEBRAE OF THE NECK ARE TERMED "
1000 INPUT S$
1010 IF S$="CERVICAL" THEN 1480
1020 GOTO 1650
1030 PRINT"THE TWELVE VERTEBRAE OF THE CHEST HAVING RIB ATTACHMENTS ARE TERME
1040 INPUT T$
1050 IF T$="THORACIC" THEN 1480
1060 GOTO 1650
1070 PRINT "THE FIVE VERTEBRAE OF THE LOWER BACK ARE TERMED "
1080 INPUT U$
1090 IF U$="LUMBAR" THEN 1480
1100 GOTO 1650
1110 PRINT "THE LAST LUMBAR VERTEBRAE ATTACHES TO WHICH BONE OF THE SPINE"
1120 INPUT V$
1130 IF V$="SACRUM" THEN 1480
1140 GOTO 1650
1150 PRINT "THE VERTEBRAE THAT ATTACHES TO THE SKULL IS DESIGNATED"
1160 INPUT W$
1170 IF W$="C1" THEN 1480
1180 GOTO 1650
1190 PRINT "THE LAST NECK VERTEBRAE IS DESIGNATED"
1200 INPUT X$
1210 IF X$="C7" THEN 1480
1220 GOTO 1650
1230 PRINT "THE VERTEBRAE THAT ATTACHES TO THE SACRUM IS DESIGNATED"
1240 INPUT Y$
1250 IF Y$="L5" THEN 1480
1260 GOTO 1650
1270 PRINT "THE LAST VERTEBRAE WITH ATTACHED RIBS IS DESIGNATED "
1280 INPUT Z$
1290 IF Z$="T12" THEN 1480
1300 GOTO 1650
1310 PRINT "THE LARGEST OF THE THREE HIP BONES IS TERMED"
1320 INPUT A$
1330 IF A$="ILIUM"THEN 1480
1340 GOTO 1650
1350 PRINT"THE PELVIC BONE JUST BENEATH THE PUBIC HAIR IS TERMED ??"
1360 INPUT B$
1370 IF B$="PUBIC"THEN1480
1380 GOTO 1650
1390PRINT "THE PELVIC GIRDLE BONE WHICH FORMS THE LOWER BORDER OF THE "
1400 PRINT "OBTURATOR FORAMEN IS TERMED "
1410 INPUT C$
1420 IF C$="ISCHIUM"THEN 1480
1430 GOTO 1650
1440 PRINT "THE POINTED TIP OF THE STERNUM IS TERMED"
1450 INPUT D$
1460 IF D$="XYPHOID"THEN 1480
1470 GOTO 1650
1480 LET J=J+1
```

ANAT-2 (CONTINUED)

```
1481
1482
1483 REM     LINES 1490-1760, GENERATES RANDOM SELECTION OF STATEMENTS WHICH
1484 REM     ACKNOWLEDGE THE CORRECTNESS OR INCORRECTNESS OF THE ANSWER.
1485
1486
1490 LET A=1
1500 LET B=6
1510 LET D= RND ◆ (B-A)+A
1515PRINT
1520 ON D GO TO 1530,1550,1570,1590,1610
1530 PRINT "HEY ";A1$;",THAT'S RIGHT!!!"
1540 GO TO 1630
1550 PRINT"RIGHT ON "; A1$;"!!!"
1560 GO TO 1630
1570 PRINT"OKAY ";A1$;",I'LL ACCEPT THAT!!!"
1580 GO TO 1630
1590 PRINT"YES ";A1$;",THAT'S RIGHT!!!"
1600 GO TO 1630
1610 PRINT"GREAT,";A1$;"!!!THAT'S RIGHT!!!"
1620 GO TO 1630
1630 IF W=88 THEN 3020
1631 PRINT "YOU NOW HAVE  ";J ;"CORRECT AND  ";Q-J ;"INCORRECT RESPONSES"
1632 IF Q-J=10 THEN 4500
1635 PRINT
1640 GO TO 1790
1645 PRINT
1650 LET A=1
1651 LET B=6
1652 PRINT
1653 PRINT
1660 LET E= RND ◆ (B-A)+A
1670 ON E GO TO 1680,1700,1720,1740,1760
1680 PRINT"SORRY ";A1$;",THAT'S WRONG!!!"
1690 GO TO 1780
1700 PRINT A1$;" YOU'VE GOT TO BE KIDDING!!!"
1710 GO TO 1780
1720 PRINT "YOU ARE WRONG ";A1$
1730 GO TO 1780
1740 PRINT"NOT HARDLY,";A1$
1750 GO TO 1780
1760 PRINT "TOO BAD,";A1$;" ,YOU ARE WRONG !! "
1770 GO TO 1780
1780 PRINT "CHECK YOUR SPELLING OR GRAMMAR !!!"
1785 PRINT
1787 GO TO  1630
1790 PRINT "DO YOU WANT ANOTHER QUESTION ?? TYPE YES OR NO --";
1800 INPUT T$
1801 PRINT
1805 PRINT
```

ANAT-2 (CONTINUED)

```
1810 IF T$="YES" THEN 87
1820 IF T$="NO" THEN 1830
1825 GOTO 1790
1830 PRINT A1$;", YOUR TOTAL SCORE WAS";INT (J/Q*100);"PERCENT CORRECT"
1840 IF J/Q>.90 THEN 1890
1850 IF J/Q>.80 THEN 1910
1860 IF J/Q>.70 THEN 1930
1870 IF J/Q>.50 THEN 1950
1880 IF J/Q>-1 THEN 1970
1890 PRINT " EXCELLENT !!!   YOUR GRADE IS ... A  "
1900 GOTO 3000
1910 PRINT " SAY,  PRETTY GOOD !!   YOUR GRADE IS ... B  "
1920 GOTO 3000
1930 PRINT " NOT TOO BAD !   YOUR GRADE IS ...  C"
1940 GOTO 3000
1950 PRINT " SORRY, BETTER LUCK NEXT TIME !   YOUR GRADE IS ... D  "
1960 GOTO 3000
1970 PRINT "YOU COULD HAVE DONE BETTER THAN THAT !!  STUDY AND TRY AGAIN  "
1980 GO TO 3000
2030 PRINT "IDENTIFY THE BONE AT THE BASE OF THE SKULL WHICH CONTAINS"
2040 PRINT "THE LARGE FORAMEN MAGNUM"
2050 INPUT A$
2060 IF A$="OCCIPITAL" THEN 1480
2070 GOTO 1650
2080 PRINT "IDENTIFY THE TERM FOR THE LOWER JAW"
2090 INPUT B$
2100 IF B$="MANDIBLE" THEN 1480
2110 GOTO 1650
2120 PRINT "IDENTIFY THE TERM FOR THE UPPER JAW"
2130 INPUT C$
2140 IF C$="MAXILLA" THEN 1480
2150 GOTO 1650
2160 PRINT "THE CHEEK BONE OF THE SKULL IS TERMED"
2170 INPUT D$
2180 IF D$ ="ZYGOMA" THEN 1480
2190 GOTO 1650
2200 PRINT "THE SKULL BONE WHICH CONTAINS THE EAR PASSAGE IS TERMED "
2210 INPUT E$
2220 IF E$="TEMPORAL" THEN 1480
2230 GOTO 1650
2240 PRINT "MOST OF THE SKULL CAP IS FORMED BY WHICH BONE PAIR???"
2250 INPUT F$
2260 IF F$="PARIETAL" THEN 1480
2270 GOTO 1650
2271 PRINT "THE SKULL BONE WHICH FORMS THE FOREHEAD IS TERMED ?"
2272 INPUT G$
2273 IF G$ ="FRONTAL" THEN 1480
2274 GOTO 1650
2275 PRINT"THE BONE IN THE FLOOR OF THE SKULL THAT RESEMBLES A BAT IS TERMED"
2276 INPUT H$
```

ANAT-2 (CONTINUED)

```
2277 IF H$ ="SPHENOID"THEN 1480
2278 GOTO 1650
2279 PRINT "THE PITUITARY GLAND IS LOCATED IN THE SELLA TURCIA DEPRESSION"
2280 PRINT "OF WHICH SKULL BONE ? "
2281 INPUT I$
2282 IF I$="SPHENOID" THEN 1480
2283 GOTO 1650
2284 PRINT"THE CRIBIFORM PLATE THROUGH WHICH PASSES OLFACTORY NERVES OF"
2285 PRINT"SMELL IS A FEATURE OF WHICH SKULL BONE ? "
2286 INPUT J$
2287 IF J$="ETHMOID" THEN 1480
2288 GOTO 1650
2289 PRINT"IDENTIFY THE SKULL SUTURE BETWEEN THE TWO PARIETAL BONES THAT"
2290 PRINT "PASSES ACROSS THE TOP OF THE SKULL"
2291INPUT K$
2292 IF K$="SAGITTAL" THEN 1480
2293 GOTO 1650
2294 PRINT "IDENTIFY THE POSTERIOR SKULL SUTURE BETWEEN THE PARIETALS AND"
2295 PRINT"OCCIPITAL BONE"
2296 INPUT L$
2297 IF L$="LAMBDOIDAL" THEN 1480
2298 GOTO 1650
2299 PRINT "THE SO CALLED SOFT SPOTS OF THE SKULL WHERE OSSIFICATION IS"
2300 PRINT "INCOMPLETE ARE TERMED ? "
2301 INPUT M$
2302 IF M$="FONTANELS" THEN 1480
2303 GOTO 1650
2500 STOP
3000 PRINT
3010 PRINT
3015 FILE #1:"BONES"
3018 PRINT #1:A1$;" ";B1$,Q;" ATTEMPTS",INT(J/Q*100);"PERCENT",DAT$;" ";CLK$
3019 PRINT
3020 PRINT "WOULD YOU LIKE TO TRY ANY OF THE QUESTIONS AGAIN ??"
3021 PRINT "TYPE YES OR NO"
3022 INPUT G$
3023 IF G$="YES" THEN 3028
3024 IF G$="NO" THEN 5000
3025 GO TO 3021
3028 PRINT "WHAT IS THE QUESTION NUMBER ??";
3029 INPUT G
3030 LET X=G
3031 LET W=88
3032 GO TO 95
3040 PRINT "THIS PROGRAM IS NOW TERMINATED !!!"
3041 PRINT
3042 PRINT
3043 PRINT
3044 PRINT
3050 GO TO 5000
```

ANAT-2 (CONTINUED)

```
3100 PRINT"THE OSSIFICATION PROCESS THAT FORMS THE BONES OF THE FACE AND"
3110 PRINT"SKULL IS TERMED ??  "
3120 INPUT A$
3130 IF A$="INTRAMEMBRANOUS" THEN 1480
3140 GO TO 1650
3150 PRINT "THE OSSIFICATION PROCESS THAT FORMS ALL BONES OF THE BODY"
3160 PRINT "EXCEPT SKULL AND FACE BONES IS TERMED ??"
3170 INPUT B4$
3180 IF B4$="ENDOCHONDRAL" THEN 1480
3190 GO TO 1650
3200 PRINT "THE CELL RESPONSIBLE FOR THE SECRETION OF THE PROTEIN MATRIX"
3210 PRINT "IN WHICH BONY SALTS ARE PRECIPITATED IN THE OSSIFICATION PROCESS"
3220 INPUT C4$
3230 IF C4$="OSTEOBLAST " THEN 1480
3240 GO TO 1650
3250 PRINT "NAME THE CELLS RESPONSIBLE FOR BONE REABSORBTION"
3260 INPUT D4$
3270 IF D4$="OSTEOCLASTS" THEN 1480
3280 GO TO 1650
3290 PRINT "CELLS WHICH PRODUCE CARTILAGE ARE TERMED ?? "
3300 INPUT E4$
3310 IF E4$="CHONDROCYTES" THEN 1480
3320 GO TO 1650
3330 PRINT"VITAMIN D DEFICIENCY IN THE ELDERLY RESULTS IN A PATHOLOGY TERMED"
3335 INPUT F4$
3350 IF F4$="OSTEOMALACIA" THEN 1480
3360 GO TO 1650
3370 PRINT"A BREAK IN BONE OR CARTILAGE IS TERMED ??"
3380 INPUT G4$
3390 IF G4$="FRACTURE" THEN 1480
3400 GO TO 1650
3410 PRINT "A FRACTURE WHERE THE SKIN IS BROKEN IS TERMED ??"
3420 INPUT H4$
3430 IF H4$="COMPOUND" THEN 1480
3440 GO TO 1650
3450 PRINT"BONES OF THE UPPER AND LOWER EXTREMITY CONPRISE THE ----- SKELETON"
3460 INPUT I4$
3470 IF I4$="APPENDICULAR" THEN 1480
3480 GO TO 1650
3490 PRINT "BONES OF THE SKULL,VERTEBRAE,RIBS,STERNUM,AND HYOID COMPRISE"
3500 PRINT"THE ----- SKELETON"
3510 INPUT J4$
3520 IF J4$="AXIAL" THEN 1480
3530 GO TO 1650
3540 PRINT"DENSE,STRONG BONE WHERE THE LAMELLAE OF MINERAL DEPOSIT ARE"
3550 PRINT"CLOSELY SPACED IS CLASSIFIED AS -----  BONE."
3560 INPUT K4$
3570 IF K4$="COMPACT" THEN 1480
3580 GO TO 1650
3590 PRINT"SPONGY OR LACY APPERARING BONE IS TERMED ----- BONE."
```

ANAT-2 (CONTINUED)

```
3600 INPUT L4$
3610 IF L4$="CANCELLOUS" THEN 1480
3620 GO TO 1650
3630 PRINT"SINCE THE SKULL RESTS ON THE FIRST CERVICAL VERTEBRAE, THIS"
3640 PRINT "VERTEBRAE COULD BE CALLED THE ----- ??"
3650 INPUT M4$
3660 IF M4$="ATLAS" THEN 1480
3670 GO TO 1650
3680 PRINT "SINCE THE SECOND CERVICAL VERTEBRAE PIVOTS ON THE FIRST"
3690 PRINT "CERVICAL VERTEBRAE, THIS  C2 VERTEBRAE COULD BE TERMED ?"
3700 INPUT N4$
3710 IF N4$="AXIS" THEN 1480
3720 GO TO 1650
3800 PRINT"THE TISSUE CONSISTING OF MANY BONE CELLS IS TERMED ----- TISSUE"
3810 INPUT A5$
3820 IF A5$="OSSEOUS" THEN 1480
3830 GO TO 1650
3840 PRINT "THE RED , BLOOD PRODUCING TISSUE FOUND WITHIN BONES IS TERMED ? "
3850 INPUT B5$
3860 IF B5$="MARROW" THEN 1480
3870 GO TO 1650
3880 PRINT"THE ROUNDED JOINT ENDS OF A BONE IS TERMED ?? "
3890 INPUT C5$
3900 IF C5$="EPIPHYSIS" THEN 1480
4000 GO TO 1650
4010 PRINT "THE SHAFT OF LONG BONES IS TERMED ??"
4020 INPUT D5$
4030 IF D5$="DIAPHYSIS" THEN 1480
4040 GO TO 1650
4050 PRINT "THE SPACE WITHIN BONES WHERE MARROW IS LOCATED IS TERMED"
4060 PRINT "THE --------  CAVITY"
4070 INPUT E5$
4080 IF E5$="MEDULLARY" THEN 1480
4090 GO TO 1650
4100 PRINT "THE CONNECTIVE TISSUE SHEATH WHICH COVERS THE BONE IS TERMED ?"
4110 INPUT F5$
4120 IF F5$="PERIOSTEUM" THEN 1480
4130 GO TO 1650
4140 PRINT "BONE TISSUE IS NOT SOLID BUT IS TRAVERSED BY A NETWORK OF"
4150 PRINT "CANALS CONTAINING NERVES AND BLOOD VESSELS. THE ENTIRE"
4160 PRINT "NETWORK IS TERMED THE  --------  SYSTEM"
4170 INPUT G5$
4180 IF G5$="HAVERSIAN" THEN 1480
4190 GO TO 1650
4200 PRINT "THE U-SHAPED BONE LOCATED ANTERIORLY IN THE UPPER NECK IS TERMED"
4210 INPUT H5$
4220 IF H5$="HYOID" THEN 1480
4230 GO TO 1650
4240 PRINT"A LATERAL ABNORMAL CURVATURE OF THE SPINAL COLUMN IS TERMED ??"
4250 INPUT I5$
```

ANAT-2 (CONTINUED)

```
4260 IF I5$="SCOLIOSIS" THEN 1480
4270 GO TO 1650
4280 PRINT"A FRACTURE WHERE THE BONE IS SPLINTERED INTO SMALL FRAGMENTS"
4290 PRINT "IS TERMED ??? "
4300 INPUT J5$
4310 IF J5$="COMMINUTED" THEN 1480
4320 GO TO 1650
4330 PRINT "AN INCOMPLETE BONE FRACTURE WHICH OFTEN RESULTS IN BENDING OR"
4340 PRINT "BOWING OF THE BONE IS TERMED ??"
4350 INPUT K5$
4360 IF K5$="GREENSTICK" THEN 1480
4370 GO TO 1650
4380 PRINT "INFLAMMATION OF BONE IS TERMED ??"
4390 INPUT L5$
4400 IF L5$="OSTEITIS" THEN 1480
4410 GO TO 1650
4420 PRINT "A BONE FRACTURE WHICH RESULTS IN AN OPEN WOUND IS TERMED ??"
4430 INPUT M5$
4440 IF M5$="COMPOUND" THEN 1480
4450 GOTO 4500
4455 PRINT"YOU HAVE MADE TEN INCORRECT RESPONSES!!! IT IS SUGGESTED"
4456 PRINT "WHICH OF THE FOUR BASIC TISSUE TYPES WOULD BONE BE CONSIDERED?"
4457 INPUT F$
4458 IF F$="CONNECTIVE" THEN 1480
4459 IF F$="CONNECTIVE TISSUE" THEN 1480
4460 GO TO 1650
4461 PRINT "WHICH MINERAL IS MOST IMPORTANT IN THE COMPOSITION OF BONE ?"
4462 INPUT F$
4463 IF F$="CALCIUM" THEN 1480
4464 GO TO 1650
4465 PRINT "A BONE WHOSE SHAFT LENGTH IS LONGER THAN ITS WIDTH WOULD BE"
4466 PRINT "CLASSIFIED AS A ---------- BONE."
4467 INPUT F$
4468 IF F$="LONG" THEN 1480
4469 GOTO 1650
4470 PRINT "THE VERTEBRAE WOULD BE CLASSIFIED AS AN --------- BONE."
4471 INPUT F$
4472 IF F$="IRREGULAR" THEN 1480
4473 GO TO 1650
4474 PRINT "CELLS CAPIBLE OF DISSOLVING BONEY MINERAL ARE CALLED ???"
4475 INPUT F$
4476 IF F$="OSTEOCLASTS" THEN 1480
4477 GO TO 1650
4478 PRINT "THE CARTILAGE GROWTH ZONES FOUND IN THE BONE EXTREMITIES ARE"
4479 PRINT "TERMED ?? ( TWO WORDS )"
4480 INPUT F$
4481 IF F$="EPIPHYSEAL PLATES" THEN 1480
4482 GO TO 1650
4483 PRINT "WHAT IS THE TOTAL NUMBER OF BONES FOUND IN THE HUMAN BODY ??"
4484 INPUT F
```

ANAT-2 (CONTINUED)

```
4485 IF F=206 THEN 1480
4486 GOTO 1650
4487 PRINT "WHAT TERM REFERS TO THE BLOOD FORMING FUNCTION OF BONE ??"
4488 INPUT F$
4489 IF F$="HEMATOPOIESIS" THEN 1480
4490 GO TO 1650
4491 PRINT "(TRUE OR FALSE) ONE THIRD OF THE MATURE BONE'S WEIGHT IS ORGANIC ?
4492 INPUT F$
4493 IF F$="TRUE" THEN 1480
4494 GO TO 1650
4495 PRINT "THE PATELLA BONE WOULD BE CLASSIFIED AS A --------- BONE."
4496 INPUT F$
4497 IF F$="SESAMOID" THEN 1480
4498 GO TO 1650
4500 PRINT A1$;" YOU HAVE MADE TEN INCORRECT RESPONSES !!!  IT IS SUGGESTED"
4501 PRINT      " THAT YOU REVIEW THE MATERIAL AND TRY AGAIN LATER"
5000 PRINT
5001 PRINT
5002 PRINT
5003 PRINT "THIS PROGRAM IS NOW TERMINATED !!!"
5004 PRINT
5005 PRINT
6000 END
```

APPENDIX F

APPENDIX F

RAW TEST DATA

EXPERIMENTAL GROUP I

Pretest Test Scores (Percentage Correct)

This table constitutes the pretest scores for experimental Group I that will receive the experimental protocol and be post-tested as Class B.

20	40	50	60	65	70	75	85
35	45	50	60	70	70	80	85
35	50	55	65	70	70	80	90
40	50	60	65	70	70	80	

Statistics:
Number of items = 31
Summation of Items = 1910
Mean Value = 61.6
Variance = 285.645
Standard Deviation = 16.901

Post-Test Test Scores (Percentage Correct)

This table constitutes the post-test scores for experimental Group I following instruction augmented with the CAI and PAL experimental protocol.

54	82	88	93	97
56	86	88	93	100
70	88	90	95	100
81	88	90	95	100
81	88	93	95	100

Statistics:
Number of Items = 25
Summation of Items = 2191
Mean Value = 87.6
Variance = 146.907
Standard Deviation = 12.1205

APPENDIX F (continued)

EXPERIMENTAL GROUP II

Pretest Test Scores (Percentage Correct)

This table constitutes the pretest scores for experimental Group II that will receive the usual instructional strategy and be post-tested as Class D.

10	30	50	60	75	85	95
20	40	55	65	75	85	95
25	40	55	65	80	85	
25	50	60	70	80	90	

Statistics:

Number of Items	=	26
Summation of Items	=	1565
Mean Value	=	60.2
Variance	=	604.962
Standard Deviation	=	24.596

Post-test Test Scores (Percentage Correct)

This table constitutes the post-test scores for experimental Group II following the usual instructional strategy of lecture-recitation.

40	70	75	85	85	90	95
45	70	80	85	85	90	95
55	70	80	85	85	90	
55	75	85	85	90	95	

Statistics:

Number of Items	=	26
Summation of Items	=	2040
Mean Value	=	78.5
Variance	=	225.538
Standard Deviation	=	15.0179

APPENDIX F (continued)

EXPERIMENTAL GROUP III

Class E Test Scores (Percentage Correct)

Class E constitutes the post-test scores for experimental Group III. This group was only post-tested following administration of the CAI and PAL experimental protocol.

59	72	80	82	83	91	92	97
63	73	81	83	84	92	95	98
68	75	82	83	85	92	96	100
72	80	82	83	91	92	96	

Statistics:
Number of Items = 31
Summation of Items = 2602
Mean Value = 83.9
Variance = 108.462
Standard Deviation = 10.4145

EXPERIMENTAL GROUP IV

Class F Test Scores (Percentage Correct)

Class F constitutes the post-test scores for experimental Group IV. This group was only post-tested following the usual instructional strategy of lecture-recitation.

40	60	76	80	94
54	63	76	80	98
55	66	78	83	98
56	68	78	81	
58	75	79	90	

Statistics:
Number of Items = 23
Summation of Items = 1620
Mean Value = 73.5
Variance = 229.806
Standard Deviation = 15.1594

APPENDIX G

APPENDIX G

COMPUTER PROGRAM IN BASIC
STATISTICAL ANALYSIS OF UNMATCHED AND UNEQUAL DATA SAMPLES

Graph

```
1 REM 'OPERATIONAL PROGRAM TITLED GRAPH'
2 REM 'A SUBPROGRAM TITLED GRAPH2 IS ALSO USED'
3 LIBRARY "GRAPH2"
100 PRINT "


          "
120 PRINT TAB(5);"**** STATISITCAL ANALYSIS OF UNMATCHED AND
    UNEQUAL DATA SAMPLES"
125 PRINT "

          "
130 PRINT "ANALYSIS DESCRIPTION ________________________________ "

135 PRINT "


          "
140 DIM D(60)
150 DIM I(60)
155 DIM U(60)
160 LET N=1
161 LET S=1
170 READ X
180 IF X=0 THEN 220
190 LET I(N)=X
200 LET N=N+1
210 GO TO 170
220 READ X
221 IF X=0 THEN 230
222 LET U(S)=X
223 LET S=S+1
224 GO TO 220
230 LET S1=0
235 LET A=1
240 LET S1=I(A)+S1
250 IF A=N THEN 280
260 LET A=A+1
270 GO TO 240
280 LET N=N-1
```

GRAPH (CONTINUED)

```
290 LET X1=S1/N
300 LET A=1
310 LET D(A)=I(A)-X1
320 IF A=N THEN 350
330 LET A=A+1
340 GO TO 310
350 LET A=1
360 LET Z=D(A)*D(A)
370 LET S3=S3+Z
380 IF A=N THEN 410
390 LET A=A+1
400 GO TO 360
410 LET V=S3/(N-1)
420 PRINT TAB(23);"DATA SAMPLE ONE:
                                                 "
430 PRINT,,"NUMBER OF ITEMS              =";N
440 PRINT,,"SUMMATION OF ITEMS           =";S1
450 PRINT,,"MEAN VALUE                   =";X1
455 PRINT,,"VARIANCE                     =";V
460 PRINT,,"STANDARD DEVIATION           =";SQR(V)
470 PRINT"


          "
471 GO TO 674
479 LET N2=G
480 CALL "GRAPH2":V2,N2,X2,U()
490 LET V1=((N-1)*V+(N2-1)*V2)/((N-1)+(N2-1))
500 LET S5=SQR(V1)
510 LET T1=X1-X2
520 LET T2=S5*SQR((1/N)+(1/N2))
530 LET T=T1/T2
540 PRINT TAB(23);"POOLED DATA ANALYSIS:"
550 PRINT
560 PRINT TAB(30);"TOTAL ITEM NUMBER              =";N+N2
570 PRINT TAB(30);"POOLED VARIANCE                =";V1
580 PRINT TAB(30);"POOLED STANDARD DEVIATION      =";S5
590 PRINT TAB(30);"T DISTRIBUTION                 =";T
600 PRINT TAB(30);"POOLED DEGREES OF FREEDOM      =";N+N2-2
610 PRINT "



          "
620 PRINT TAB(23);"ANALYSIS OF VARIANCE:"
630 PRINT
640 PRINT TAB(30);"F DISTRIBUTION VALUE           =";T^2
650 PRINT TAB(30);"NUMERATOR DEG. FREEDOM         =";2-1
660 PRINT TAB(30);"DENOMINATOR DEG. FREEDOM       =";N+N2-2
661 LET Z=4.17-((N-30)*.00566)
```

GRAPH (CONTINUED)

```
662 PRINT TAB(30);"CRITICAL (F)                      =";Z
663 IF T^2 <Z THEN 666
664 PRINT TAB(30);"EVALUATION AT .05 LEVEL    = SIGNIFICANT"
665 GO TO 1200
666 PRINT TAB(30);"EVALUATION AT .05 LEVEL    = NOT SIGNIFICANT"
667 GO TO 1200
674 PRINT "GROUP ONE PERCENTAGE SCORES :

                                                   ";
685 FOR A=1 TO N
690 FOR P=1 TO N
700 IF I(A)<I(P) THEN 750
710 NEXT P
720 NEXT A
725 GO TO 790
750 LET Z=I(A)
760 LET I(A)=I(P)
770 LET I(P)=Z
780 GO TO 710
790 FOR A=1 TO N
800 PRINT I(A);
810 NEXT A
811 PRINT"

          "
812 PRINT "GRAPHIC ANALYSIS OF GROUP ONE SCORES

                                                          "
820 FOR A=1 TO N
830 LET D=I(A)-40
850 NEXT A
860 FOR A=1 TO N
865 GO TO 875
870 IF A=N THEN 1010
872 NEXT A
875 IF I(A)<=40 THEN 940
880 IF I(A)<=45 THEN 945
885 IFI(A)<=50 THEN 950
890 IF I(A)<= 55 THEN 955
895 IF I(A)<= 60 THEN 960
900 IF I(A)<=65 THEN 965
905 IF I(A)=<70 THEN 970
910 IF I(A)<=75 THEN 975
915 IF I(A)<=80 THEN 980
920 IF I(A)<=85 THEN 985
925 IF I(A)<=90 THEN 990
930 IF I(A)<=95 THEN 995
935 IF I(A)<=100 THEN 1000
937 GO TO 1010
940 LET P(1)=P(1)+1
```

GRAPH (CONTINUED)

```
942 GO TO 870
945 LET P(2)=P(2)+1
947 GO TO 870
950 LET P(3)=P(3)+1
952 GO TO 870
955 LET P(4)=P(4)+1
957 GO TO 870
960 LET P(5)=P(5)+1
962 GO TO 870
965 LET P(6)=P(6)+1
967 GO TO 870
970 LET P(7)=P(7)+1
972 GO TO 870
975 LET P(8)=P(8)+1
977 GO TO 870
980 LET P(9)=P(9)+1
982 GO TO 870
985 LET P(10)=P(10)+1
987 GO TO 870
990 LET P(11)=P(11)+1
992 GO TO 870
995 LET P(12)=P(12)+1
997 GO TO 870
1000 LET P(13)=P(13)+1
1005 GO TO 870
1010 FOR P=0 TO 100 STEP 2
1020 FOR A=1 TO N
1030 IF I(A)=P THEN 1080
1035 IF I(A)=P+1 THEN 1080
1040 IF A=N THEN 1110
1050 NEXT A
1055 IF A=N THEN 1110
1060 PRINT " "
1065 IF P=100 THEN 1170
1070 NEXT P
1080 LET C=C+1
1090 GO TO 1050
1110 IF P=100 THEN 1165
1112 PRINT P;"-";P+1;
1115 IF C=0 THEN 1060
1130 PRINT "*";
1140 LET C=C-1
1150 IF C=0 THEN 1060
1160 GO TO 1130
1165 PRINT TAB(4);P;
1166 GO TO 1115
1170 GO TO 479
1200 PRINT "
```

GRAPH (CONTINUED)

```
"
1250 PRINT "END


                    "
1500 DATA 70,85,85,70,70,20,35,70,55,70,40,50,50,
0,80,65,75,40,35,80,90
1520 DATA 0
1700 DATA 25,70,10,65,40,75,50,55,30,25,35,60,85,
0,50,55
1720 DATA 0
2000 END
```

GRAPH2

```
1 SUB "GRAPH2":V,N,X1,I()
2 DIM P(13)
130 PRINT"

            "
140 DIM D(60)
220 LET S1=0
230 LET A=1
240 LET S1=I(A)+S1
250 IF A=N THEN 280
260 LET A=A+1
270 GO TO 240
280 LET N=N-1
290 LET X1=S1/N
300 LET A=1
310 LET D(A)=I(A)-X1
320 IF A=N THEN 350
330 LET A=A+1
340 GO TO 310
350 LET A=1
360 LET Z=D(A)*D(A)
370 LET S3=S3+Z
380 IF A=N THEN 410
390 LET A=A+1
400 GO TO 360
410 LET V=S3/(N-1)
420 PRINT TAB(23);"DATA SAMPLE TWO:
                                                    "
430 PRINT,,"NUMBER OF ITEMS                    =";N
440 PRINT,,"SUMMATION OF ITEMS                 =";S1
450 PRINT,,"MEAN VALUE                         =";X1
455 PRINT,,"VARIANCE                           =";V
460 PRINT,,"STANDARD DEVIATION                 =";SQR(V)
470 PRINT"


            "
673 PRINT "

             "
674 PRINT "GROUP TWO PERCENTAGE SCORES :

                                                       "
685 FOR A=1 TON
690 FOR P=1 TO N
700 IF I(A)<I(P) THEN 750
710 NEXT P
720 NEXT A
725 GO TO 790
750 LET Z=I(A)
```

GRAPH2 (CONTINUED)

```
760 LET I(A)=I(P)
770 LET I(P)=Z
780 GO TO 710
790 FOR A=1 TO N
800 PRINT I(A);
810 NEXT A
811 PRINT"

          "
812 PRINT "GRAPHIC ANALYSIS OF GROUP TWO SCORES

                                                "
820 FOR A=1 TO N
830 LET D=I(A)-40
850 NEXT A
860 FOR A=1 TO N
865 GO TO 875
870 IF A=N THEN 1010
872 NEXT A
875 IF I(A)<=40 THEN 940
880 IF I(A)<=45 THEN 945
885 IFI(A)<=50 THEN 950
890 IF I(A)<= 55 THEN 955
895 IF I(A)<= 60 THEN 960
900 IF I(A)<=65 THEN 965
905 IF I(A)=<70 THEN 970
910 IF I(A)<=75 THEN 975
915 IF I(A)<=80 THEN 980
920 IF I(A)<=85 THEN 985
925 IF I(A)<=90 THEN 990
930 IF I(A)<=95 THEN 995
935 IF I(A)<=100 THEN 1000
937 GO TO 1010
940 LET P(1)=P(1)+1
942 GO TO 870
945 LET P(2)=P(2)+1
947 GO TO 870
950 LET P(3)=P(3)+1
952 GO TO 870
955 LET P(4)=P(4)+1
957 GO TO 870
960 LET P(5)=P(5)+1
962 GO TO 870
965 LET P(6)=P(6)+1
967 GO TO 870
970 LET P(7)=P(7)+1
972 GO TO 870
975 LET P(8)=P(8)+1
977 GO TO 870
980 LET P(9)=P(9)+1
```

GRAPH2 (CONTINUED)

```
982 GO TO 870
985 LET P(10)=P(10)+1
987 GO TO 870
990 LET P(11)=P(11)+1
992 GO TO 870
995ET P(12)=P(12)+1
997 GO TO 870
1000 LET P(13)=P(13)+1
1005 GO TO 870
1010 FOR P=0 TO 100 STEP 2
1020 FOR A=1 TO N
1030 IF I(A)=P THEN 1080
1035 IF I(A)=P+1 THEN 1080
1040 IF A=N THEN 1110
1050 NEXT A
1055 A=N THEN 1110
1060 PRINT " "
1065 IF P=100 THEN 1170
1070 NEXT P
1080 LET C=C+1
1090 GO TO 1050
1110 IF P=100 THEN 1165
1112 PRINT P;"-";P+1;
1115 IF C=0 THEN 1060
1130 PRINT "*";
1140 LET C=C-1
1150 IF C=0 THEN 1060
1160 GO TO 1130
1165 PRINT TAB(4);P;
1166 GO TO 1115
1170 SUBEND
```

APPENDIX H

APPENDIX H

QUESTIONNAIRE

STUDENT EVALUATION OF INSTRUCTION

Please, submit a brief response to each question. Your evaluation will be most helpful in planning continuance of this program.

1. What did you like BEST about the Peer Teaching and Learning Sessions?

2. What did you like LEAST about the Peer Teaching and Learning Sessions?

3. What recommendations would you suggest for improvement of the Peer Teaching and Learning Sessions?

4. What did you like BEST about the Computer Drill and Practice Sessions?

5. What did you like LEAST about the Computer Drill and Practice Sessions?

6. What recommendations would you suggest for improvement of the Computer Drill and Practice Sessions?

APPENDIX I

APPENDIX I

STUDENT OPINION TOWARD PEER ASSISTED LEARNING

1. The PAL sessions challenged me to do my best work.

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

2. I found the PAL sessions embarrassing and uncomfortable.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

3. I would prefer the usual classroom teaching and learning format.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

4. Having to teach fellow classmates enabled me to learn more effectively.

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

5. Peer teaching was an inefficient use of class time.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

6. Classmate assistance with study and learning would have resulted without the formal program.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

7. I felt capable of teaching my material to fellow classmates.

All the time	Most of the time	Some of the time	Very seldom	Never

APPENDIX I (continued)

8. The assigned time for the Peer sessions was adequate.

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

9. I would recommend the use of Peer teaching for other courses.

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

10. Individual personality differences made cooperation awkward.

Never	Very Seldom	Some of the time	Most of the time	All the time

11. I found it difficult to explain scientific concepts to fellow classmates.

Never	Very Seldom	Some of the time	Most of the time	All the time

12. It was especially difficult to make myself understood.

Never	Very Seldom	Some of the time	Most of the time	All the time

13. I would enroll in additional anatomy classes where PAL was being used.

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

14. I particularly enjoy the involvement and participation afforded by the PAL sessions.

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

15. I would prefer to have all of the teaching done by the instructor.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

APPENDIX J

APPENDIX J

STUDENT OPINION TOWARD COMPUTER ASSISTED INSTRUCTION

1. The method by which I was told whether I had given a right or wrong answer became monotonous.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

2. I felt challenged to do my best work.

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

3. I felt as if someone were engaged in conversation with me.

All the time	Most of the time	Some of the time	Very Seldom	Never

4. I was more involved in operating the terminal than in understanding the course material.

Never	Very Seldom	Some of the time	Most of the time	All the time

5. The learning was too mechanical.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

6. I felt as if I had a private tutor.

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

7. The equipment made it difficult to concentrate on the course material.

Never	Very Seldom	Some of the time	Most of the time	All the time

APPENDIX J (continued)

8. Computer Assisted Instruction, as used in this course, is an inefficient use of the student's time.

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

9. I felt frustrated by the situation.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

10. I found the Computer Assisted Instruction approach in this course to be inflexible.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

11. I was satisfied with what I learned while working with the computer.

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

12. I would prefer Computer Assisted Instruction to traditional instruction.

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

13. Computer Assisted Instruction is just another step toward depersonalized instruction.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

14. I was not concerned when I missed a question because nobody was watching me.

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

15. I found myself trying to get through the material rather than trying to learn.

Never	Very Seldom	Some of the time	Most of the time	All the time

16. I felt I could work at my own pace.

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

APPENDIX J (continued)

17. Questions were asked which I felt were not related to the material presented.

Never	Very Seldom	Some of the time	Most of the time	All the time

18. Material which is otherwise boring can be interesting when presented by CAI.

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

19. The CAI material was presented too slowly.

Never	Very Seldom	Some of the time	Most of the time	All the time

20. Computer malfunctions made learning difficult.

Never	Very Seldom	Some of the time	Most of the time	All the time

21. Computer Assisted Instruction makes it possible for me to learn quickly.

Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

APPENDIX K

APPENDIX K

DATA TABLE ONE

STATISTICAL COMPARISON OF EXPERIMENTAL GROUP ONE PRETEST SCORES WITH CONTROL GROUP TWO PRETEST SCORES

Objective: To test for randomly equated assortment.

Experimental Group One Pretest Data

Number of Items	=	31
Summation of Items	=	1910
Mean Value	=	61.6
Variance	=	285.6
Standard Deviation	=	16.9

Control Group Two Pretest Data

Number of Items	=	26
Summation of Items	=	1565
Mean Value	=	60.1
Variance	=	604.9
Standard Deviation	=	24.5

Pooled Data Analysis

Total Item Number	=	57
Pooled Variance	=	430.78
Pooled Standard Deviation	=	20.75
T Distribution	=	0.25
Pooled Degrees of Freedom	=	55

Analysis of Variance

F Distribution Value	=	0.06
Numerator Deg. Freedom	=	1
Denominator Deg. Freedom	=	55
Critical F Value	=	4.02
Evaluation at .05 Level	=	Not significant

APPENDIX K (continued)

DATA TABLE TWO

STATISTICAL COMPARISON OF CONTROL GROUP TWO PRETEST SCORES AND POST-TEST SCORES

Objective: To test the main effect of the traditional teaching format with a pretested group.

Control Group Two Pretest Data

Number of Scores	=	26
Summation of Scores	=	1565
Mean Value	=	60.1 $\pm$ 9.8
Variance	=	604.9
Standard Deviation	=	24.5

Control Group Two Post-Test Data

Number of Scores	=	26
Summation of Scores	=	2040
Mean Value	=	78.4 $\pm$ 6.0
Variance	=	225.5
Standard Deviation	=	15.0

Pooled Data Analysis

Total Number of Scores	=	52
Pooled Variance	=	415.25
Pooled Standard Deviation	=	20.37
T Distribution	=	3.23
Pooled Degrees of Freedom	=	50

Analysis of Variance

F Distribution Value	=	10.44
Numerator Deg. Freedom	=	1
Denominator Deg. Freedom	=	50
Critical F Value	=	4.03
Evaluation at .05 Level	=	Significant

APPENDIX K (continued)

DATA TABLE THREE

STATISTICAL COMPARISON OF POST-TEST SCORES FOR CONTROL GROUPS TWO AND FOUR

Objective: To test the prompting influence of pretesting in the control groups.

Control Group Two (Pretested)

Number of Items	=	26
Summation of Items	=	2040
Mean Value	=	78.4 $\pm$ 6.0
Variance	=	225.5
Standard Deviation	=	15.0

Control Group Four (Not Pretested)

Number of Items	=	23
Summation of Items	=	1690
Mean Value	=	73.4 $\pm$ 6.4
Variance	=	229.8
Standard Deviation	=	15.1

Pooled Data Analysis

Total Item Number	=	49
Pooled Variance	=	227.53
Pooled Standard Deviation	=	15.08
T Distribution	=	1.15
Pooled Degrees of Freedom	=	47

Analysis of Variance

F Distribution Value	=	1.33
Numerator Deg. Freedom	=	1
Denominator Deg. Freedom	=	47
Critical F Value	=	4.04
Evaluation at .05 Level	=	Not significant

APPENDIX K (continued)

DATA TABLE FOUR

STATISTICAL COMPARISON OF GROUP ONE PRETEST SCORES WITH POST-TEST SCORES OF GROUP ONE

Objective: To test the main effect of experimental treatment in Group One.

Experimental Group One Pretest Data

Number of Scores	=	31
Summation of Scores	=	1910
Mean Value	=	61.6 $\pm$ 6.2
Variance	=	285.6
Standard Deviation	=	16.9

Experimental Group One Post-Test Data

Number of Scores	=	25
Summation of Scores	=	2191
Mean Value	=	87.6 $\pm$ 4.9
Variance	=	146.9
Standard Deviation	=	12.1

Pooled Data Analysis

Total Item Number	=	56
Pooled Variance	=	223.98
Pooled Standard Deviation	=	14.96
T Distribution	=	6.46
Pooled Degrees of Freedom	=	54

Analysis of Variance

F Distribution Value	=	41.85
Numerator Deg. Freedom	=	1
Denominator Deg. Freedom	=	54
Critical F Value	=	4.02
Evaluation at .05 Level	=	Significant

APPENDIX K (continued)

DATA TABLE FIVE

STATISTICAL COMPARISON OF GROUP TWO POST-TEST SCORES WITH GROUP ONE POST-TEST SCORES

Objective: To test the main effect of experimental treatment in the pretested groups.

Control Group Two Post-Test Data

Number of Scores	=	26
Summation of Scores	=	2040
Mean Value	=	78.4 $\pm$ 6.0
Variance	=	225.5
Standard Deviation	=	15.0

Experimental Group One Post-Test Data

Number of Scores	=	25
Summation of Scores	=	2191
Mean Value	=	87.6 $\pm$ 4.9
Variance	=	146.9
Standard Deviation	=	12.1

Pooled Data Analysis

Total Number of Scores	=	51
Pooled Variance	=	187.02
Pooled Standard Deviation	=	13.67
T Distribution	=	2.39
Pooled Degrees of Freedom	=	49

Analysis of Variance

F Distribution Value	=	5.74
Numerator Deg. Freedom	=	1
Denominator Deg. Freedom	=	49
Critical F Value	=	4.03
Evaluation at .05 Level	=	Significant

APPENDIX K (continued)

DATA TABLE SIX

STATISTICAL COMPARISON OF GROUP THREE POST-TEST SCORES WITH GROUP FOUR POST-TEST SCORES

Objective: To test the main effect of experimental treatment in groups not pretested.

Experimental Group Three Post-Test Data

Number of Scores	=	31
Summation of Scores	=	2602
Mean Value	=	83.9 $\pm$ 3.8
Variance	=	108.4
Standard Deviation	=	10.4

Control Group Four Post-Test Data

Number of Scores	=	23
Summation of Scores	=	1690
Mean Value	=	73.4 $\pm$ 6.4
Variance	=	229.8
Standard Deviation	=	15.1

Pooled Data Analysis

Total Number of Scores	=	54
Pooled Variance	=	159.80
Pooled Standard Deviation	=	12.64
T Distribution	=	3.00
Pooled Degrees of Freedom	=	52

Analysis of Variance

F Distribution Value	=	9.03
Numerator Deg. Freedom	=	1
Denominator Deg. Freedom	=	52
Critical F Value	=	4.03
Evaluation at .05 Level	=	Significant

APPENDIX K (continued)

DATA TABLE SEVEN

STATISTICAL COMPARISON OF POST-TEST SCORES FOR EXPERIMENTAL GROUPS ONE AND THREE

Objective: To test the prompting influence of pretesting in the experimental groups.

Experimental Group One (Pretested)

Number of Scores	=	25
Summation of Scores	=	2193
Mean Value	=	87.9 $\pm$ 4.9
Variance	=	147.9
Standard Deviation	=	12.1

Experimental Group Three (Not Pretested)

Number of Scores	=	31
Summation of Scores	=	2592
Mean Value	=	83.6 $\pm$ 3.8
Variance	=	106.9
Standard Deviation	=	10.3

Pooled Data Analysis

Total Number of Scores	=	56
Pooled Variance	=	125.17
Pooled Standard Deviation	=	11.18
T Distribution	=	1.43
Pooled Degrees of Freedom	=	54

Analysis of Variance

F Distribution Value	=	2.05
Numerator Deg. Freedom	=	1
Denominator Deg. Freedom	=	54
Critical F Value	=	4.02
Evaluation at .05 Level	=	Not significant

APPENDIX K (continued)

DATA TABLE EIGHT

STATISTICAL ANALYSIS OF COMBINED PRETESTED GROUPS ONE AND TWO COMPARED WITH COMBINED GROUPS THREE AND FOUR NOT PRETESTED

Objective: To test the prompting influence of pretesting.

Groups One and Two (Pretested)

Number of Scores	=	51
Summation of Scores	=	4231
Mean Value	=	82.9 $\pm$ 4.3
Variance	=	204.7
Standard Deviation	=	14.3

Groups Three and Four (not Pretested)

Number of Scores	=	54
Summation of Scores	=	4283
Mean Value	=	79.3 $\pm$ 3.9
Variance	=	182.0
Standard Deviation	=	13.4

Pooled Data Analysis

Total Number of Scores	=	105
Pooled Variance	=	193.06
Pooled Standard Deviation	=	13.89
T Distribution	=	1.34
Pooled Degrees of Freedom	=	103

Analysis of Variance

F Distribution Value	=	1.80
Numerator Deg. Freedom	=	1
Denominator Deg. Freedom	=	103
Critical F Value	=	4.05
Evaluation at .05 Level	=	Not significant

APPENDIX K (continued)

DATA TABLE NINE

STATISTICAL COMPARISON OF GROUP TWO PRETEST SCORES WITH GROUP FOUR POST-TEST SCORES

Objective: To test the main effect of experimental treatment in a group not pretested. The pretest scores of Group Two were used for comparison.

Group Two Pretest Data

Number of Scores	=	26
Summation of Scores	=	1565
Mean Value	=	60.1 $\pm$ 9.8
Variance	=	604.9
Standard Deviation	=	24.5

Group Four Post-Test Data

Number of Scores	=	31
Summation of Scores	=	2592
Mean Value	=	83.6 $\pm$ 3.8
Variance	=	106.9
Standard Deviation	=	10.3

Pooled Data Analysis

Total Number of Scores	=	57
Pooled Variance	=	333.33
Pooled Standard Deviation	=	18.25
T Distribution	=	4.82
Pooled Degrees of Freedom	=	55

Analysis of Variance

F Distribution Value	=	23.26
Numerator Deg. Freedom	=	1
Denominator Deg. Freedom	=	55
Critical F Value	=	4.02
Evaluation at .05 Level	=	Significant

APPENDIX K (continued)

DATA TABLE TEN

STATISTICAL COMPARISON OF COMBINED CONTROL GROUPS WITH COMBINED EXPERIMENTAL GROUPS

Objective: To test the main effect of experimental treatment on the combined experimental groups.

Combined Control Groups Two and Four Post-Test Data

Number of Scores	=	49
Summation of Scores	=	3730
Mean Value	=	76.1 $\pm$ 4.6
Variance	=	229.1
Standard Deviation	=	15.1

Combined Experimental Groups One and Three Post-Test Data

Number of Scores	=	56
Summation of Scores	=	4781
Mean Value	=	85.3 $\pm$ 3.2
Variance	=	126.7
Standard Deviation	=	11.2

Pooled Data Analysis

Total Number of Scores	=	105
Pooled Variance	=	174.47
Pooled Standard Deviation	=	13.20
T Distribution	=	3.48
Pooled Degrees of Freedom	=	103

Analysis of Variance

F Distribution Value	=	12.82
Numerator Deg. Freedom	=	1
Denominator Deg. Freedom	=	103
Critical F Value	=	3.95
Evaluation at .05 Level	=	Significant

APPENDIX K (continued)

DATA TABLE ELEVEN

VARIANCE ANALYSIS OF MEAN STUDY TIME

Control Group Receiving Usual Instructional Format

Number of Items	=	48
Summation of Items	=	208
Mean Value	=	4.33 Hours
95% Confidence Limit	=	+/- .54
Variance	=	3.75
Standard Deviation	=	1.93

Treatment Group Receiving PAL/CAI Augmented Instruction

Number of Items	=	56
Summation of Items	=	167
Mean Value	=	2.98 Hours
95% Confidence Limit	=	+/- .34
Variance	=	1.72
Standard Deviation	=	1.31

Pooled Data Analysis

Total Item Number	=	104
Pooled Variance	=	2.66
Pooled Standard Deviation	=	1.63
T Distribution	=	4.20
Pooled Degrees of Freedom	=	102

Analysis of Variance

F Distribution Value	=	17.71
Numerator Deg. Freedom	=	1
Denominator Deg. Freedom	=	102
Critical F Value	=	3.94
Evaluation at .05 Level	=	Significant

APPENDIX K (continued)

DATA TABLE TWELVE

VARIANCE ANALYSIS OF MEAN POST-TEST SPELLING ERRORS

Control Group Receiving Usual Instructional Format

Number of Items	=	48
Summation of Items	=	449
Mean Value	=	9.35
95% Confidence Limit	=	+/- .89
Variation	=	9.93
Standard Deviation	=	3.15

Treatment Group Receiving PAL/CAI Augmented Instruction

Number of Items	=	56
Summation of Items	=	372
Mean Value	=	6.64
95% Confidence Limit	=	+/- .81
Variance	=	9.57
Standard Deviation	=	3.09

Pooled Data Analysis

Total Item Number	=	104
Pooled Variance	=	9.74
Pooled Standard Deviation	=	3.12
T Distribution	=	4.41
Pooled Degrees of Freedom	=	102

Analysis of Variance

F Distribution	=	19.50
Numerator Deg. Freedom	=	1
Denominator Deg. Freedom	=	102
Critical F Value	=	3.94
Evaluation at .05 Level	=	Significant

APPENDIX K (continued)

DATA TABLE THIRTEEN

VARIANCE ANALYSIS OF POST-TEST SCORES FOR GROUP RECEIVING CAI AUGMENTED INSTRUCTION WITH GROUP RECEIVING BOTH PAL AND CAI AUGMENTED INSTRUCTION

CAI Augmented Instruction

Number of Items	=	19
Summation of Items	=	1360
Mean Value	=	71.57
95% Confidence Limit	=	+/- 3.78
Variance	=	70.81
Standard Deviation	=	8.41

CAI and PAL Augmented Instruction

Number of Items	=	31
Summation of Items	=	2602
Mean Value	=	83.93
95% Confidence Limit	=	+/- 3.66
Variance	=	108.46
Standard Deviation	=	10.41

Pooled Data Analysis

Total Item Number	=	50
Pooled Variance	=	94.34
Pooled Standard Deviation	=	9.71
T Distribution	=	4.36
Pooled Degrees of Freedom	=	48

Analysis of Variance

F Distribution Value	=	19.06
Numerator Deg. Freedom	=	1
Denominator Deg. Freedom	=	48
Critical F Value	=	4.04
Evaluation at .05 Level	=	Significant

APPENDIX K (continued)

DATA TABLE FOURTEEN

VARIANCE ANALYSIS OF POST-TEST SCORES FOR GROUP RECEIVING PAL AUGMENTED INSTRUCTION COMPARED WITH GROUP RECEIVING BOTH PAL AND CAI AUGMENTED INSTRUCTION

PAL Augmented Instruction

Number of Items	=	21
Summation of Items	=	1552
Mean Value	=	73.90
95% Confidence Limit	=	+/- 2.54
Variance	=	35.39
Standard Deviation	=	5.94

CAI and PAL Augmented Instruction

Number of Items	=	31
Summation of Items	=	2602
Mean Value	=	83.93
95% Confidence Limit	=	+/- 3.66
Variance	=	108.46
Standard Deviation	=	10.41

Pooled Data Analysis

Total Item Number	=	52
Pooled Variance	=	79.23
Pooled Standard Deviation	-	8.90
T Distribution	=	3.98
Pooled Degrees of Freedom	=	50

Analysis of Variance

F Distribution Value	=	15.89
Numerator Deg. Freedom	=	1
Denominator Deg. Freedom	=	50
Critical F Value	=	4.03
Evaluation at .05 Level	=	Significant

APPENDIX K (continued)

DATA TABLE FIFTEEN

VARIANCE ANALYSIS OF POST-TEST SCORES FOR GROUP RECEIVING USUAL INSTRUCTIONAL PROTOCOL COMPARED WITH GROUP RECEIVING CAI AUGMENTED INSTRUCTION

CAI Augmented Instruction

Number of Items	=	19
Summation of Items	=	1360
Mean Value	=	71.57
95% Confidence Limit	=	+/- 3.78
Variance	=	70.81
Standard Deviation	=	8.41

Usual Instructional Protocol

Number of Items	=	23
Summation of Items	=	1686
Mean Value	=	73.30
95% Confidence Limit	=	+/- 6.14
Variance	=	226.31
Standard Deviation	=	15.04

Pooled Data Analysis

Total Item Number	=	42
Pooled Variance	=	156.33
Pooled Standard Deviation	=	12.50
T Distribution	=	.44
Pooled Degrees of Freedom	=	40

Analysis of Variance

F Distribution Value	=	.19
Numerator Deg. Freedom	=	1
Denominator Deg. Freedom	=	40
Critical F Value	=	4.08
Evaluation at .05 Level	=	Not significant

APPENDIX K (continued)

DATA TABLE SIXTEEN

VARIANCE ANALYSIS OF POST-TEST SCORES FOR GROUP RECEIVING USUAL INSTRUCTIONAL PROTOCOL COMPARED WITH GROUP RECEIVING PAL AUGMENTED INSTRUCTION

PAL Augmented Instruction

Number of Items	=	21
Summation of Items	=	1552
Mean Value	=	73.90
95% Confidence Limit	=	+/- 2.54
Variance	=	35.39
Standard Deviation	=	5.94

Usual Instructional Protocol

Number of Items	=	23
Summation of Items	=	1686
Mean Value	=	73.30
95% Confidence Limit	=	+/- 6.14
Variance	=	226.31
Standard Deviation	=	15.04

Pooled Data Analysis

Total Item Number	=	44
Pooled Variance	=	135.39
Pooled Standard Deviation	=	11.63
T Distribution	=	.17
Pooled Degrees of Freedom	=	42

Analysis of Variance

F Distribution Value	=	.29
Numerator Deg. Freedom	=	1
Denominator Deg. Freedom	=	42
Critical F Value	=	4.07
Evaluation at .05 Level	=	Not significant

APPENDIX K (continued)

DATA TABLE SEVENTEEN

VARIANCE ANALYSIS OF POST-TEST SCORES FOR GROUP RECEIVING CAI AUGMENTED INSTRUCTION WITH GROUP RECEIVING PAL AUGMENTED INSTRUCTION

CAI Augmented Instruction

Number of Items	=	19
Summation of Items	=	1360
Mean Value	=	71.57
95% Confidence Limit	=	+/- 3.78
Variance	=	70.81
Standard Deviation	=	8.41

PAL Augmented Instruction

Number of Items	=	21
Summation of Items	=	1552
Mean Value	=	73.90
95% Confidence Limit	=	+/- 2.54
Variance	=	35.39
Standard Deviation	=	5.94

Pooled Data Analysis

Total Item Number	=	40
Pooled Variance	=	52.16
Pooled Standard Deviation	=	7.22
T Distribution	=	1.01
Pooled Degrees of Freedom	=	38

Analysis of Variance

F Distribution Value	=	1.03
Numerator Deg. Freedom	=	1
Denominator Deg. Freedom	=	38
Critical F Value	=	4.10
Evaluation at .05 Level	=	Not significant

APPENDIX K (continued)

DATA TABLE EIGHTEEN

QUESTIONNAIRE RESPONSE
STUDENT OPINION TOWARD PEER ASSISTED LEARNING

1. The PAL sessions challenged me to do my best work.

1	2	3	4	5
Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
33%	37%	19%	6%	5%

MEAN RESPONSE: 2.13

2. I found the PAL sessions embarrassing and uncomfortable.

1	2	3	4	5
Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
54%	34%	6%	4%	2%

MEAN RESPONSE: 1.66

3. I would prefer the usual classroom teaching and learning format.

1	2	3	4	5
Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
12%	26%	17%	37%	8%

MEAN RESPONSE: 3.03

4. Having to teach fellow classmates enabled me to learn more effectively.

1	2	3	4	5
Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
3%	42%	22%	27%	6%

MEAN RESPONSE: 2.91

APPENDIX K (continued)

5. Peer teaching was an inefficient use of class time.

1	2	3	4	5
Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
21%	67%	7%	2%	3%

MEAN RESPONSE: 1.99

6. Classmate assistance with study and learning would have resulted without the formal program.

1	2	3	4	5
Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
1%	18%	28%	51%	2%

MEAN RESPONSE: 3.35

7. I felt capable of teaching my material to fellow classmates.

1	2	3	4	5
All the time	Most of the time	Some of the time	Very Seldom	Never
1%	72%	24%	2%	1%

MEAN RESPONSE: 2.30

8. The assigned time for the peer sessions was adequate.

1	2	3	4	5
Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1%	27%	46%	23%	3%

MEAN RESPONSE: 3.00

9. I would recommend the use of peer teaching for other courses.

1	2	3	4	5
Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
13%	44%	18%	24%	1%

MEAN RESPONSE: 2.56

APPENDIX K (continued)

10. Individual personality differences made cooperation awkward.

1	2	3	4	5
Never	Very Seldom	Some of the time	Most of the time	All the time
6%	8%	73%	12%	1%

MEAN RESPONSE: 2.98

11. I found it difficult to explain scientific concepts to fellow classmates.

1	2	3	4	5
Never	Very Seldom	Some of the time	Most of the time	All the time
1%	6%	83%	8%	2%

MEAN RESPONSE: 3.04

12. It was especially difficult to make myself understood.

1	2	3	4	5
Never	Very Seldom	Some of the time	Most of the time	All the time
1%	14%	72%	11%	1%

MEAN RESPONSE: 2.91

13. I would enroll in additional anatomy classes where PAL was being used.

1	2	3	4	5
Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1%	19%	66%	12%	1%

MEAN RESPONSE: 2.90

APPENDIX K (continued)

14. I particularly enjoy the involvement and participation afforded by the PAL sessions.

1	2	3	4	5
Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
16%	72%	6%	5%	1%

MEAN RESPONSE: 2.03

15. I would prefer to have all of the teaching done by the instructor.

1	2	3	4	5
Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
13%	40%	26%	19%	2%

MEAN RESPONSE: 2.57

OVERALL QUESTIONNAIRE MEAN: 2.62

APPENDIX K (continued)

DATA TABLE NINETEEN

QUESTIONNAIRE RESPONSE
STUDENT OPINION TOWARD COMPUTER ASSISTED INSTRUCTION

1. The method by which I was told whether I had given a right or wrong answer became monotonous.

1	2	3	4	5
Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
1%	26%	33%	37%	3%

MEAN RESPONSE: 3.15

2. I felt challenged to do my best work.

1	2	3	4	5
Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
8%	54%	17%	17%	4%

MEAN RESPONSE: 2.55

3. I felt as if someone were engated in conversation with me.

1	2	3	4	5
All the time	Most of the time	Some of the time	Very Seldom	Never
7%	68%	21%	3%	1%

4. I was more involved in operating the terminal than in understanding the course material.

1	2	3	4	5
Never	Very Seldom	Some of the time	Most of the time	All the time
78%	14%	7%	1%	0%

MEAN RESPONSE: 1.31

APPENDIX K (continued)

5. The learning was too mechanical.

1	2	3	4	5
Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
9%	39%	28%	22%	2%

MEAN RESPONSE: 2.69

6. I felt as if I had a private tutor.

1	2	3	4	5
Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
16%	63%	12%	7%	2%

MEAN RESPONSE: 2.16

7. The equipment made it difficult to concentrate on the course material.

1	2	3	4	5
Never	Very Seldom	Some of the time	Most of the time	All the time
17%	25%	53%	2%	3%

MEAN RESPONSE: 2.49

8. Computer Assisted Instruction, as used in this course, is an inefficient use of the student's time.

1	2	3	4	5
Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
11%	48%	34%	4%	3%

MEAN RESPONSE: 2.60

9. I felt frustrated by the situation.

1	2	3	4	5
Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
4%	71%	12%	8%	5%

MEAN RESPONSE: 2.39

APPENDIX K (continued)

10. I found the Computer Assisted Instruction approach in this course to be inflexible.

1	2	3	4	5
Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
2%	21%	38%	32%	9%

MEAN RESPONSE: 3.31

11. I was satisfied with what I learned while working with the computer.

1	2	3	4	5
Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
14%	68%	8%	3%	7%

MEAN RESPONSE: 2.21

12. I would prefer Computer Assisted Instruction to traditional instruction.

1	2	3	4	5
Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
4%	10%	44%	31%	11%

MEAN RESPONSE: 3.35

13. Computer Assisted Instruction is just another step toward depersonalized instruction.

1	2	3	4	5
Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
6%	26%	34%	17%	17%

MEAN RESPONSE: 3.13

14. I was not concerned when I missed a question because nobody was watching me.

1	2	3	4	5
Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
4%	24%	31%	27%	14%

MEAN RESPONSE: 3.23

APPENDIX K (continued)

15. I found myself trying to get through the material rather than trying to learn.

1	2	3	4	5
Never	Very Seldom	Some of the time	Most of the time	All the time
8%	38%	41%	13%	0%

MEAN RESPONSE: 2.59

16. I felt I could work at my own pace.

1	2	3	4	5
Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
21%	62%	13%	4%	0%

MEAN RESPONSE: 2.00

17. Questions were asked which I felt were not related to the material presented.

1	2	3	4	5
Never	Very Seldom	Some of the time	Most of the time	All the time
3%	74%	22%	1%	0%

MEAN RESPONSE: 2.21

18. Material which is otherwise boring can be interesting when presented by CAI.

1	2	3	4	5
Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
7%	36%	29%	26%	2%

MEAN RESPONSE: 2.80

APPENDIX K (continued)

19. The CAI material was presented too slowly.

1	2	3	4	5
Never	Very Seldom	Some of the time	Most of the time	All the time
0%	24%	57%	17%	2%

MEAN RESPONSE: 2.97

20. Computer malfunctions made learning difficult.

1	2	3	4	5
Never	Very Seldom	Some of the time	Most of the time	All the time
0%	3%	83%	13%	1%

MEAN RESPONSE: 3.12

21. Computer Assisted Instruction makes it possible for me to learn quickly.

1	2	3	4	5
Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
19%	52%	16%	10%	3%

MEAN RESPONSE: 2.26

APPENDIX L

APPENDIX L

BIOGRAPHICAL DATA SHEET

Date of Birth__________ Place of Birth______________________

Age ____ Sex ___ M S D W, School Last Attended ______________

_____________________ Year _________

Education (check one)

High School only _____

College 1 yr. 2 yr. 3 yr. 4 yr.

College Degree? ____ Baccalaureate ____ or Associate ____

Major Academic Interest ______________________________________

Minor Academic Interest ______________________________________

High School GAP ______ Date of Graduation ___________________

College GPA __________ Date of Graduation ___________________

Have you had any background experience related to Human Anatomy and Physiology?

Have you had any prior experience with computer operations?

Bio-Science Courses Taken and Completed. Indicate by placing course grade in proper column.

	High School	College Level
Health	______	______
General Science	______	______
Biology	______	______
Advanced Biology	______	______
Human Biology	______	______
Zoology	______	______
Botany	______	______
Ecology	______	______
General Physiology	______	______
Human Anatomy	______	______
Comparative Anatomy	______	______
OTHER __________________	______	______

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