Differences in the degree of learning of students taught using computer aided-mastery learning versus expository instruction

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DIFFERENCES IN THE DEGREE OF LEARNING OF STUDENTS
TAUGHT USING COMPUTER AIDED-MASTERY LEARNING
VERSUS EXPOSITORY INSTRUCTION

by

Essington R. Wade

A thesis submitted in partial fulfillment
of the requirements for the degree of

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in

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ABSTRACT

The purpose of this study was to ascertain the differences between two teaching methods (traditional instruction and computer aided-mastery learning), and the degree of learning of students enrolled in basic electronics at a technical high school, for the 1993-94 and 1994-95 school years. The electronics department had used an expository method to deliver electronics instruction for the past eight years. Computer aided-mastery learning was used for the first time during the 1994-95 school year. Twenty four teacher made tests were used to assess degree of learning. Two independent t-tests were used to compare the means of each group. The groups were subdivided into two quarters (quarter one started the first week in September and ended mid-November, and quarter two started mid-November and ended the second week in January) for both school years. The findings of the first quarter indicated no significant differences between the two group; however, the findings of the second quarter indicated significant differences favoring the mastery learning group. This study provided the electronics instructor and district curriculum specialist with an independent assessment of the newly implemented mastery learning program.
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CHAPTER 1

INTRODUCTION

Over 25 years ago, Benjamin Bloom conducted a study he called the "two sigma" challenge. Bloom (1968) revealed that students who received individualized peer tutoring scored about two standard deviations better than students in regular classrooms. Bloom's study lead to what is known as the Mastery Learning Theory.

Most teachers are in favor of individualized instruction. Fixed time and large classes are the two major hurdles which limit individualized teaching. Guskey (1985) claims that mastery learning provides teachers with a strategy to better individualize their teaching within a group-based classroom.

Background for the Study

Education is the foundation of any industrialized nation. In order for America to compete and contribute to the global community, education must be at the top of the agenda. President Bush (1991) had this to say about education: “Think about every problem, every challenge we face, the solutions to each starts with education. For the sake of the future, of our children and of the nation’s we must transform America's schools. The days of the status quo are over.”

The need to educate students and prepare them for technical and other well paid jobs starts with a quality education. No longer can one
survive in the job market with just a general education. In order for
America to accomplish any educational goal, specific boundaries must be
established for educational excellence. According to Law (1994):

American education in many ways is still based on the traditional
book-centered curriculum of the industrial age. Because of
advances in technology and in our knowledge of how children learn,
there is clearly a need for fundamental change, if we are to prepare
America’s youth for higher education and the workplace. In a world
in which skills over-shadow content, we must provide experiences
that will encourage students to solve problems, to become adept at
using technology, to think, to use research as a vehicle to learn, and
to base their learning on conceptual and technical knowledge
(p. XI).

It is time to restructure schools and give students an education that
they can use. Students should not be promoted until they have
demonstrated competency at the grade level they are at. Wheele
supported this notion when he wrote:

Promoting students who are not ready is social promotion, a kind
term for a criminal practice: herding tens of thousands of students
through a school system without demanding high standards and
providing students with the help they need to meet them. “We are
still moving kids out of grammar school who come out with a piece of
paper saying they’re graduates—but they come into high schools
with their, fourth and fifth grade reading levels” (p. 87).

The two questions of great concern among educational re-searchers
are, (a) why don’t students learn what they are taught, and (b) why are
teachers not teaching the students what they need to know? Consider
what four teachers had to say about these issues. The four excerpts that
follow are from a book entitled *Reclaiming our Schools* (Wheele, 1994).

Although they are not scientific in nature they do provoke thought:

> We are tired of machines that don't work. We are tired of ordering books and getting the wrong ones. Most of us now just let them gather dust in the book room. As a qualified teacher who has to work with a "free ride" principal, I have given up. I have been in [the principal's] office more times this year than in my previous long career. OK, if [the principal] wants the animals passed at any cost, that is what the [the principle] will get. But the students won’t get an education (p.89).

> Our kids do not have the slightest idea about proper behavior in a classroom. They are loud, crude and very often extremely dumb and/or lazy. Most want something for nothing (the welfare mentally). They are street smart and great con artists. They intimidate the teachers. Teachers rarely speak out because they are afraid of repercussions. So, we plod along hating every minute of it and looking forward to the day’s end or the weekend or the next vacation. There is no reward being a teacher other than the paycheck. What is still amazing to me is that 99 percent of the teachers still go into the classroom each day and try like hell to present lessons (p.89).

> I'm heartened by today’s youngsters. I find great hope in their ability to cope and seek for better answers. A teacher can’t let the bureaucratic system cloud the way, or be an excuse for not caring about the students and their future (p.90).

> Why don’t I feel like ‘Burnt Out Teachers?’ Maybe it’s because I feel that I have been called to teach. Maybe it’s because I feel that in some small way, I am making a difference in some child’s life. All I know is that I love children and I love teaching (p.90). The concerns expressed by the four teachers are concerns that educational researchers are continually examining. They are looking for ways that assist teachers and maximize the learning experience.

> Proponents of mastery learning claims that mastery learning allows students to be more successful and by being more successful they tend to
be more disciplined. Disciplined students coupled with teachers who are less frustrated are more likely to enhance learning.

According to Kounin (1970) the vast majority of discipline problems involve students who are having academic difficulties and experiencing few learning successes. Guskey (1985) reported that many teachers report that discipline problems are dramatically reduced in mastery learning classes. If discipline problems are reduced, degree of learning is likely to increase.

Statement of the Problem

The literature suggests that more research is needed to determine the differences between traditional instruction and mastery learning, in regards to the degree of learning of students enrolled in occupational disciplines. There are many students, who are graduating from high school, who are not capable of meeting the technological demands of our rapidly changing society. It appears as though the instructional methods used to prepare students in occupational course for the world of work needs to be reevaluated. According to the National Commission on Excellence in Education (1984):

Our society is obsessively concerned with higher education as a preparation for work, and downgrades the intrinsic, lifelong value of education. Our secondary schools reflects this obsession by valuing only the college-bond. Such a narrow focus ignores the fact that approximately 80 percent of the jobs in America do not require a college degree, and most students will not obtain one. This educational myopia that pervades our society produces predictable results (p.1).
Occupational subjects need to be reemphasized in the high schools to help those students who choose not to go to college. Electronics, like other occupational subjects, is not just about terms, concepts and formulas. In order to compete, high school graduates with electronics background who enter the world of work must have as many “hands-on” experiences as possible. The skills that are needed are knowledge and experience in wiring circuits, building circuits, troubleshooting, soldering, and other related tasks that comprise the “hands-on” aspect of electronics.

Although the literature suggests that mastery learning is an effective method to deliver vocational subjects, a large number of instructors are still reluctant to try it. Computer aided instruction also appears to be an effective means of transferring information in a vocational setting, but here again there’s resistance by some instructors. Education is undergoing some major changes to better prepare students for the world of work. Computer aided instruction is a method which has been predicted as a tool to enhance student preparation for the rapidly changing work-force.

According to Underwood and Underwood (1990) computers play an increasing role in our everyday lives, and children should be educated in their use and in their principles of operation, in preparation for their encounters with them in the workplace and elsewhere. In 1966, Patrick
Suppes predicted that development in educational technology, and specifically in computer usage, would change the face of education in a very short space of time. Computers are widely used in the classroom. The question is how to use them most effectively in terms of student achievement.

**Purpose of the Study**

The purpose of this study was to ascertain the differences between two teaching methods (traditional instruction and mastery learning), and the degree of learning of students enrolled in basic electronics at a technical high school, for the 1993-94 and 1994-95 school years. The electronics department had used an expository method to deliver electronics instruction for the past eight years. Computer aided-mastery learning was used for the first time during the 1994-95 school year.

**Research Questions**

Does a significant difference exist between mastery/computer aided approach to teaching electronics, and the traditional expository/lab approach to teaching electronics? Specifically, (a) Do differences exist in the degree of learning attained by students measured by teacher made tests? ; (b) Is there sufficient time in a vocational high school setting to practice mastery learning? ; and (c) Do differences exist in the amount of learning?
Significance of the Study

In 1994 the National Assessment of Vocational Education concluded that, for the past ten years secondary vocational education has been de-emphasized in America's secondary educational system. This is exemplified by a decrease in the number of vocational teachers and university programs providing training in vocational teaching. Moreover there has been a decrease in the number of students taking vocational classes in high school. Jobs of the twenty first century appear to be more technically driven. According to The Secretary's Commission on Achieving Necessary Skill report (1992) vocational education needs to be taught in the most effective way possible to prepare students for the world of work. If there are going to be changes in America's educational school system, more research is needed in the area of vocational education. According to Slavin (1984) the primary antidote to educational change [or failure to change], based on the passion of the moment, is well-designed unbiased research. The findings of this study should help vocational schools in the following ways:

1. The data gathered from this study will provide the participating electronics department with an independent assessment of the newly implemented computer aided-mastery learning program;
2. This study should help vocational administrators by providing them with a means to examine future decisions concerning curriculum improvement;

3. Data from this study should provide cost analysis departments with inputs for future budgetary goals;

4. Finally, the electronics teacher at the participating school and other electronics teachers will have a resource for guiding curriculum decisions.

Assumptions

The present study was based on following assumptions.

1. The samples were representative of past classes within the program studied.

2. The tests used for the previous school years were equivalent to the tests used in the current year, and the instructor and subject matter were identical.

3. The scores obtained from the teacher made test were reliable.

4. All subjects had the necessary math skills needed to pass basic electronics, and all students entering the program had completed algebra I.

5. The number of students in the traditional and mastery group were the same, due to limited classroom size.

6. The number of times students meet per week (Monday to Friday three hours per session) were the same for both groups.
Limitations

The specific limitations of this study include the following:

1. Samples for this study were limited to basic electronics students who were enrolled in the program for the 1993-94 and 1994-95 school years.
2. Sample sizes were limited to the number of students enrolled for each respective school year.
3. Since 1994-95 was the first year the computer aided-mastery learning program was used, the study could not control for unforeseen errors by the instructor.
4. Students possible phobia of computers was not controlled.
5. Students were tested by means of teacher made tests, the tests were guided by the cooperating district's curriculum guide.

Definitions

Mastery Learning

Bloom (1985) believes it is possible to set the degree of learning expected of each child at some mastery performance level. Given adequate time, all or almost all students, according to Bloom, can reach a high level of achievement. He observed that in most traditional classroom settings, all students are typically provided with the same opportunity to learn and the same quality of instruction. But while these are likely to be appropriate and sufficient for some students in the class, it is likely they will be less so for others. Guskey and Gates (1986) concluded that the
The essence of mastery learning lies in establishing skills to be mastered or achieved and having an assessment or test process to determine if students have attained those skills after a segment of instruction. If students master the skill, they move to a new skill or set of skills. If they do not master the skill(s) they are recycled through supplemental instruction and reassessed (feedback-corrective-process). According to Reigeluth (1983) mastery learning occurs when most students master most objectives at a uniformly high level.

**Expository Instruction**

Orlich, et al. (1985) defined expository instruction as consisting of basic convergent patterns that allow the teacher to play a dominant role or to direct the learning activities for all students. According to Robinson (1992) the primary assumption in traditional instruction is that relatively few students will achieve an A, while the majority will cluster around a C, and the rest will fail.

**Individualized Instruction**

Hienstra and Sisco (1990) define individualized instruction as making learning personal, empowering, and successful. Individualized instruction is a comprehensive teaching and learning process that appears to ensure instructional success. The individualizing process is designed to be flexible, practical and applicable in a variety of settings, ranging from literacy instruction to training in the corporate world.
Learning Rate

Guskey (1985) suggests that students' aptitude more accurately reflects an index of learning rate. That is, all children have the potential to learn quite well, but differ in terms of the time they require to do so. When aptitude is viewed as an index of learning rate, children are seen not simply as good and poor learners but rather as faster and slower learners.

Degree of Learning

Guskey (1985) summarized degree of learning by using an equation formulated by Carroll (1963): Degree of learning = f (time spent/time needed). The degree of learning is a function of the time a child actually spends on learning relative to the time he or she needs to spend. If the time spent were equal to time needed, the learning would be complete and the equation would equal 1.

Computer Aided Instruction (CAI)

Price (1990), concluded that the operational definition of CAI is as follows: (a) CAI provides opportunities for students to control, or perceive that they control, the learning process; (b) provides interaction, feedback and often rewards; (c) allows students and/or teachers to establish and implement goals and provides for self-evaluation; (d) allows diagnosis of conceptual difficulties with materials and prescriptive branching; (e) uses the full range of hardware capabilities, such as graphics, sound and color; (f) includes important concepts as well as facts related to subject matter;
(g) includes student record-keeping capabilities and monitors student progress; (h) allows for easy operation, accompanied by clear documentation, and can be modified by teachers.

**Basic Electronics**

According to Wheeler (1989) basic electronics consist of: (a) terms and concepts concerning electricity; (b) a detailed explanation of what electricity is, how it is made, how it works, how it is measured and how it can be applied; (c) a concept of voltage, current, power, and resistance and how they inter-relate; (d) explanations of basic electrical circuits and the components that are used in such circuits; (e) explanation of the relationship between magnetism and electricity.

**Quasi-Independent Variable**

The independent variable is an alternative instructional method intended to better prepare basic electronic students for the world of work. For the purpose of this study, two instructional methods were compared with the intention of identifying differences in the degree of learning. The two instructional methods studied were the expository method and the computer aided-mastery learning method.

**Expository Method**

Basic electronics was previously taught within the program studied by means of lecture and reading assignments which highlighted basic electrical concepts, accompanied by laboratory applications of those
concepts. However, a lockstep approach was used to ensure all scheduled materials were covered. This meant that if students did not pass or did poorly on an objective they would still go on to the next objective.

**Computer Aided-Mastery Instruction**

Basic electronics at the participating school was taught by short lectures, extensive computer interaction and reading assignments which highlighted basic electrical concepts and applications just like the expository method. However, students were not allowed to go on to the next objective until they mastered (80 percent or better) the previous objective.

**Dependent Variable**

The dependent variables are means of basic electronics chapter tests (12 total) from 1993-94 and 1994-95 school years. The means were compared at the end of the first quarter and second quarter for each respective school year.

**Organization of the Study**

The organization of the study was guided by questions, concerning what instructional method(s) would best serve vocational students and the work force that they would enter after completing an occupational program. Chapter 1 was subdivided into six areas: The purpose of the study; the research questions which focused the study; a discussion of the significance of the study; coupled with specific assumptions and
limitations; definitions of significant terms; and identification of the independent variable and the dependent variables.

A concise review of pertinent literature is provided in Chapter 2. The research methodology and procedures are discussed in Chapter 3. Data analysis and findings are presented in Chapter 4. A summary, conclusions and recommendations of the study are provided in Chapter 5.
CHAPTER 2
REVIEW OF THE LITERATURE

The search for the most effective way to deliver information to students continues to be an ongoing concern for educational practitioners and researchers alike. Recognizing that concern, this study was undertaken to examine and compare several alternative ways basic electronics are taught. Three instructional methods were selected and examined for this review of literature. The three methods were: (a) expository (traditional) instruction (b) mastery learning (c) computer aided instruction (CAI)—mastery learning style. In comparing these methods, this study sought to establish whether or not mastery learning, with the aid of computers, was more effective than an expository approach towards teaching electronics.

This review of literature consists of two major sections. The first section contains selected review of literature regarding the roles that traditional education has played in the past. For example, initial reasons for public school, and a brief account of the roles which traditional education has played in the school to work transition. The second section includes the support of, and criticisms of mastery learning and CAI.

Educational Roles

There have been both positive and negative criticisms about methods of instruction in the American school system. The focus of this
study dealt with the pros and cons of three major areas which the researcher found to be most beneficial in exploring the expository method versus CAI mastery learning method with emphasis on vocational education. The three areas that guided the research are: (a) the educational climate of the past and present, (b) the role that traditional education has played in the past, and (c) the role that mastery learning (especially computer aided-mastery learning) would play in preparing students for the world of work.

**Educational Climate of the Past and Present**

According to Blank (1982), vocational education and industrial training programs have adequately served business and industry's needs for trained workers in the past; however, they have come under increasing criticism. Taxpayers, policy makers, and training directors are more reluctant to spend increasingly larger sums of money for sometimes questionable results. Both public vocational-technical education and business and industry training have been caught in the squeeze between public and corporate accountability and public school retrenchment.

President Bush in 1991 released his AMERICA 2000 plan for the sole purpose of addressing the challenges that face America then and in the years to come, and what we as a nation need to do in order to successfully transcend those challenges. His strategy towards educating the masses was summarized in six educational goals that he projected to
materialize in the year 2000 if the strategies were implemented. The goals are as follows: (a) All children in America will start school ready to learn. (b) The high school graduation rate will increase to at least 90 percent. (c) American students will leave grades four, eight, and twelve having demonstrated competency in challenging subject matter including English, mathematics, science, history, and geography; and every school in America will ensure that all students learn to use their minds well, so they may be prepared for responsible citizenship, further learning, and productive employment in our modern economy. (d) US students will be first in the world in science and mathematics achievement. (e) Every adult American will be literate and will possess the knowledge and skills necessary to compete in the global economy and exercise the right and responsibilities of citizenship. (f) Every school in America will be free of drugs and violence and will offer a disciplined environment conducive to learning.

President Bush summarized his America 2000 plan by saying: “Nothing better defines what we are and what we will become than the education of our children. To quote the landmark case, Brown v. Board of Education, It is doubtful that any child may reasonably be expected to succeed in life if [s/he] is denied the opportunity of an education” (p.1).
Although the educational future of America may seem grim to some, it is only grim to those who are not willing to take an active role in the advancement of the educational process.

In 1992 the Department of Labor accentuated the six goals of President Bush by putting out the Secretary's Commission on Achieving Necessary Skills (SCANS) report. The report was entitled A SCANS Report for America 2000. There were two pertinent messages that the report had to offer to the schools and teachers: (a) To schools, look beyond the schoolhouse to the roles students will play when they leave to become workers, parents, and citizens: (b) To teachers, look beyond your discipline and your classroom to other courses your students take, to their community, and to their lives outside of school. Help your students connect what they learn in class to the world outside.

The roles of education are rapidly changing and educators have to keep up with the changing times. A high school diploma used to mean a step towards a reasonably stable job that would sustain a family. In the 90s and beyond the value of a high school diploma will continue to decrease with regards to qualification for a job.

The time when a high school diploma was a sure ticket to a job is within the memory of workers who have not yet retired; yet in many places today a high school diploma is little more than a certificate of attendance.
As a result, employers discount the value of all diplomas, and many students do not work hard in high school (SCANS, 1992).

It appears as though the educational community has a mandate to continue to do research that will better prepare our students for the future. Americans need to envision the future and set definite goals to make sure students are highly skilled and effectively educated.

American education in many ways is still based on the traditional, book-centered curriculum of the industrial age. The point is that American society is beginning to see all work as a part of the life of every person. We are tearing down the old dualism that holds thinking work to be more important and prestigious than doing work. And because education generally reflects its social context, it appears to be reversing its historically ineffective book-centered approach, replacing it with instructional strategies that are applied, context-specific, experimental, rooted in reality, and connected with the evolving world of work (Law, 1994).

The outlook for education is only as bright as the viewers outlook. If we all look at the educational process from the same perspective the outlook would look similar. Dewey (1943) had this to say about educational outlook: "We are apt to look at the school from an individualistic standpoint, as something between teacher and pupil, or between teacher
and parent. That which interest us most is naturally the progress made by the individual child of our acquaintance (p. 6).

What is the outlook for the future of American schools? It is 1995 and we only have five more years to successfully meet President Bush's six goals for the year 2000. Are we going to be successful? The ball is in the court of every individual that has a say in the future of America's education.

**Traditional Education**

**Initial Reasons for Public Schools**

According to Borman and Greenman (1994) the public school, as we know it, was not designed to serve the population that it now serves. It is their view that in order to better educate the children of the twenty first century reorganization may be needed. Traditional education in the public school was designed to serve the political requirements articulated by the founders of the American Republic at the end of the eighteenth century and the requirements of the nineteen century industrial nation-state. Borman & Greenman (1994) also concluded that the common school was seen as a logical extension of the new knowledge, and the new politics introduced and popularized by enlightenment thinkers.

Without properly educated people the nation becomes stagnated. The lack of vital information needed to vote and make positive decisions becomes non-existent in an uneducated society. All Americans, especially the children that will eventually run the country, need to be educated at a
level that will make them productive citizens. The ability to educate all of our citizens, as proposed by Rush (1965), has been and remains a major challenge to America's educational system. The newly articulated democratic theory and the new democratic institutions required an education not only for the individual but chiefly for the good of the society. The society created by the American revolution could only be maintained by means of informed and disciplined participation of all its citizens (a citizenry that did not yet include all adults, minorities, handicapped, etc.). Compulsory attendance was established as a means to capture great minds of all forms and nurture them. According to Tyack (1974), as early as 1861 proponents of compulsory education were arguing for the establishment of industrial schools for a class of children, more or less too numerous, which were too low down in the depths of crime, poverty, and sometimes mental challenges, to be reached by the benefit of a system of public education. Cremin (1962) viewed compulsory attendance as a new era in the history of American education. The crippled, the blind, the deaf, the sick, the slow-witted, and needy arrived in growing numbers. Thousands of recalcitrance and incorrigibles who, in former times might have dropped out of school, now became public charges for a minimum period.

According to Borman & Greenman (1994) compulsory attendance was the beginning of the differential curriculum, the beginning of what
some described as course proliferation, or the abandonment of standards. The differentiated curriculum was the device that allowed the school to perform both its sorting and its custodial functions.

**Traditional Education and its Role in the School to Work**

As stated earlier, the original reason for public schools was to promote citizenry and a knowledgeable society. Working makes-up a substantial part of our citizen duties. Borman (1991) suggests that a primary purpose of schooling is to prepare people for the world of work, and that superintendents need to do a better job of insuring that school practices and policies are formulated to assist youths in making the transition from school to work.

**Ineffectiveness of Traditional Instruction**

Gallager and Pearson reported that traditional instruction has not changed in recent years. They reviewed several studies on classroom practices and concluded that from 1893 to 1979 instructional practice has remained about the same. According to Chubb and Moe (1990) traditional instruction is failing at its core academic mission, particularly in math, science and technology [electronics].

Brandt (1990) claims that teachers who continue to use the traditional method, with 85-90 percent of their instruction delivered by lectures, is using a method that does not work for most students. Teachers are co-learners and facilitators as much as lecturers and experts.
Robinson (1990) concluded that lecturing is one of the least effective instructional approaches, and yet, a very high percentage of instruction that goes on in classrooms has the teacher talking and the students listening.

In traditional instruction classes, objectives are stated in terms of global outcomes to teacher performance and are the same for all students. Few students are expected to master most objectives, and there is no provision for alteration of the objectives or instructional strategies for remediation (Gagne, Briggs & Wager, 1989).

**Mastery Learning**

Mastery learning is not a new idea in education. Apprenticeship programs (which is a mastery concept) existed many years before the coined phrase of mastery learning. In addition, several individualized systems of instruction were developed during the 1920s and 1930s. Students were required to demonstrate their mastery of each lesson on formal tests before moving on to new material (C.C. Kulik, J.A. Kulik and Drown, R.L., 1990). But mastery learning programs did not become a prominent feature on the educational landscape until the 1960s (J.A. kulik, 1983). According to Slavin (1991) two approaches were especially influential: Bloom's Learning for Mastery (LFM) and Keller's Personalized System of Instruction (PSI). In both LFM and PSI classes, topics to be
learned are divided into short units, and students take formative tests on each unit.

Like the traditional method of instruction, mastery learning has its advocates and its adversaries. There are many ways to deliver information to students. Educational researchers have, and continue to try to identify the most effective methods which are likely to enhance student learning. Student learning is not just subject matter, the dynamics of education surpasses the barriers of subject only. Educators have to keep in step with technological advancements to better prepare students for the job market. Mastery learning appears to be an instructional tool which helps students to master each respective objective before going on to new materials. As defined by Bloom (1976), mastery learning is the process of providing students the amount of time needed to master a particular level of information or skill before moving on to new material.

Numerous studies have indicated that mastery learning has been quite effective. For example, Kulik et al. (1990) reviewed and analyzed 108 evaluations of mastery learning by means of a meta-analysis. 103 of the evaluations were categorized by summative results, 96 had positive effects, 67 were statistically significant. None of the studies indicated that the mastery groups were significantly worse off than the controls [traditional]. The average student in a mastery class performed at the 70th percentile, whereas the average control students performed at the 50th
percentile, regardless of the summative test scores used. Kulik, et al. found that the success of mastery learning was very effective, particularly for low achieving students.

Criticisms

The most significant criticism of mastery learning are time constraints and the amount of content covered. According to Slavin (1991) the inherent problem in any mastery learning strategy is how to provide the additional instructional time to students who need it. Public schools are not designed to adjust the regular class time for students who may need additional time to master the information. Time is a major stumbling block for mastery learning; however, the amount of content covered is also a recognized criticism. Arlin (1984) concluded that the central problem of mastery learning is that it involves a trade off between the amount of content that can be covered and the degree to which students master each concept.

Support

Time constraints and content covered were the two major concerns of the adversaries of mastery learning. The proponents of mastery learning argue that time constraint and content covered could by remedied by a method called “time-on-learning”. Hunter, Bartz and Miller (1991) pointed out that “time-on-learning” is different than, “time-on-task”. When students simply spend time on task, there are no assurances that learning is taking
place or that instruction is being delivered at a meaningful level. Students could spend endless hours on a task, but if the task was not within their realm of understanding, the time would be wasted. The key is to apply time on learning in such a way that the instruction delivered is appropriate to the specific needs of each learner (Fisher, Marliave, and Filby, 1979).

According to Gagne (1985) the amount of “time-on-task” greatly affects the degree of learning. Teachers often feel pressured by administrators and the district curriculum guide to cover more material than students can be expected to master. Gagne saw this as a result of placing more importance on breadth of coverage than on depth (mastery).

Mastery learning have been found to yield higher achievement, increased motivation for learning, greater retention of learned material and more positive student attitudes toward themselves, their teachers, and their classmates (Block & Burns, 1976; Guskey & Pigotte, 1988; Johnson & Johnson, 1989; Johnson, Mayuyama, Johnson, Nelson, & Skon, 1981; Kulik & Kulik, 1987; Slavin, 1980).

The literature highlights far more advantages over disadvantages when it comes to mastery learning as a tool used to increase students learning. Mastery learning ensures that students are given information on their learning progress at regular intervals throughout each instructional phase. The information which is given out is normally referred to as feedback. Because of feedback, students identify what is important to
learn, and what they have learned. Another facet of mastery learning which adds to the effectiveness of the method is correctives. Correctives offer alternatives that are different from the initial teaching session. Teachers present material in a new way and involve students differently. Guskey (1989) proclaimed that feedback and corrective procedures are crucial to the mastery learning process and are the core of any mastery learning program.

In addition, the literature also suggest that mastery learning is advantageous when working with underachievers. Stallings and Stipek (1986) claimed that underachievers or at-risk--students benefit more from mastery learning, because traditional instruction focuses more on competition. When underachievers are placed in a competitive situation they tend to be less successful.

Comparison

Some educators have compared mastery learning to minimum competency. By equating those two concepts, the assumption that mastery learning is less effective than traditional instruction is amplified. According to Blank (1982) the real tragedy of the minimum competency testing movement that is sweeping the country is that it only deals with measuring competence-not teaching to competency. Since our educational system is organized around the traditional, fixed-time, instructor-centered approach, most students proceed from subject to subject and grade to grade largely
incompetent in most tasks. It is no wonder then that functional literacy exams for high school seniors must be written at the eighth grade level! The competency-based [mastery learning] approach to instruction not only insists that each student demonstrate competency, but the minimum acceptable level of competency can be set at an extremely high level and attained, because students are given the time and help needed to get there.

**Computer Aided Instruction (CAI)**

Kulik, Bangert and Williams (1983) analyzed 51 studies of CAI conducted in grades 6-12. Overall they found that the CAI raised students examination scores by .32 standard deviation and also had positive effects on students’ attitudes, and the amount of time needed for instruction. In 1986, Kulik concluded that CAI improved student achievement, saved student and teacher time, and improved student attitude toward school and particular subjects.

**Criticisms**

Although numerous researchers have concluded that CAI is effective, and increases the degree of learning for a number of students, criticisms still exist. In 1990, Becker sampled, and reported his findings of 1,416 schools in the United States. He collected data on hardware, software, computer use, and teacher attitudes. From his study he came up with three major criticisms, which he thought would limit CAI.

First, he suggested that, despite the tremendous increases in hardware and software available in schools, only a small minority of
teachers, and students, can be said to be major computer users. That is, where a large portion of instruction, learning, or productive work in their classes is being accomplished through the use of computers, the teachers and students are computer novices. There is also additional evidence which suggest that the computers that are available in a number of schools are spending most of their time switched off (Garner, 1984; Opacic ad Roberts, 1985). Underwood and Underwood (1990) also supported the claim that computers are not used enough by practitioners who may have access to them. They claim that the significant difference in perceptions of computer users versus under or non-users was expressed in terms of their confidence and their familiarity with computer technology. Not only did the under and non-users express doubts about their own abilities to use the technology, but they were also unsure as to what to do with it in the classroom. Second, Becker cited teacher attitude and lack of teacher education on computer usage as two major impediments blocking more effective and appropriate computer use. Third, he suggested that the hardware available in most schools were inadequate to support the more complex computer learning. He cited that software publishers were severely limited by the constraints of older machines.

In addition, a common concern among administrators in regard to CAI is cost effectiveness. In 1986 Levin and Meister reported their findings of a study conducted on the effectiveness of CAI. They concluded that CAI, while effective in teaching elementary reading and mathematics, was not as cost effective in some other traditional subjects.

Support

According to Bartz & Miller (1990) the two major advantages of CAI are its consistency and its ability to motivate students (as long as it is not overused). Furthermore, CAI allows for individualization, compliments students’ being independent learners, and represents an instructional
emphasis of process oriented learning that requires active participation of students.

Henson (1988) reviewed the literature to determine the effectiveness of CAI. Eight studies were cited which found that CAI either improved learning or showed no difference when compared with traditional instruction, seven studies found that CAI reduced learning time compared to the regular classroom, and six studies found that CAI improved attitudes about using computers for instruction.

According to Jackson, Fletcher and Messer (1986) teachers who received as little as a two-day in-service training on CAI were more likely to use the computers in their classrooms. It appears as though if proper computer training is administered more teachers may try the alternative method (CAI) of instruction.

As stated earlier, one of the criticism of CAI is that some educators think it is not cost effective for some traditional or even non-traditional subjects. According to Thompson (1992) when comparing cost effectiveness between programs using technology to traditional curricula, they rarely yield useful information since new programs have goals attuned to technological changes, efficiencies attributable to technology, revised roles for students, and new responsibilities for teachers.

**Summary**

According to Baker (1965) schools are necessary to meet the problems of educating students so they could better serve their communities. It is imperative that schools be based upon a full and accurate diagnosis of social situations.

The operational definition of "social situations" in regards to this
study, includes all interactions between individuals and the impact of those interactions on society. Students spend an enormous amount of time in school and if they leave school with nothing, or little to nothing, they will likely have nothing or little to nothing to contribute to society. CAI provides students with the respective subject matter information, and it also aids in the understanding and the use of computers. Society, especially the job market, tends to favor students with computer knowledge.

Practitioners and researchers of education have to continue looking for ways to increase awareness of "societal situations". The proponents of CAI and mastery learning thinks that the way to increase educational success is to implement CAI and mastery learning wherever possible. Vocational education is one area of education that requires a lot of "societal situation" training.

Conclusion

Mastery learning, as stated earlier, is not a new concept. However, mastery learning as an alternative method of instruction in public school has not widely been accepted by some educators, including administrators. Although evidence exist which states that the traditional approach to teaching and learning is unsuccessful with many students, this is not enough for some educators. Additional research is needed to provide educational practitioners and their administrators alternative instructional
methods which may improve the degree of learning.

The two alternative instructional methods that were examined during this review of literature were mastery learning and CAI. The literature on mastery learning and CAI as separate methods of delivering instruction indicated that both methods are equally effective.

Although studies suggest that each is an effective method, this study was undertaken to determine the effectiveness of the merged methodology on an individual program. The findings of this study might assist individual program practitioners with a guide to better assess where they are and where they could be in relation to improving their program.
CHAPTER 3
METHODOLOGY AND PROCEDURES

The methodology and procedures which were used in this study is found in this chapter. This chapter is sectionalized into six areas of discussion. The first section is a brief reiteration of the purpose of the study. Second is the hypothesis, third, the population and the fourth is the selection of the samples. The fifth section is instrumentation, and the sixth section is, data collection and data analysis. The chapter is brought to a close with a description of the procedures which were used in analyzing the data.

Design

This was a quasi-experiment in which two intact classes of basic electronics students were taught (by the same teacher) using two different methods of instruction. True experimental designs provide the strongest, most convincing arguments of causal effect of the independent variable because they control for the most sources of internal invalidity. Although quasi-experimental designs are not true experiments, they provide reasonable control over most sources of invalidity and they are usually stronger than the pre-experimental designs (Schumacher and McMillan, 1993).

Purpose of the Study

The purpose of this study was threefold. The purpose of the first phase was to compare the relationship between two teaching methods and the
degree of learning of students enrolled in basic electronics at an area technical high school. Second, the study was to provide an independent assessment of the newly implemented computer aided-mastery learning program at that school. Third, the overall intent of the study was to help vocational teachers examine alternative methods of teaching vocational subjects.

**Hypothesis**

To focus the research and try and answer the questions which were introduced in chapter 1 the following null hypothesis was established:

\[ H_0 : \text{There are no significant differences in the degree of learning of high school students enrolled in basic electronics if computer aided-mastery learning is used instead of expository instruction.} \]

**Population**

The population of this study were 11th and 12th grade students who were enrolled in a basic electronics class. The study consisted of students that represented 14 different high schools enrolled in classes at an area trade high school. The samples were selected from basic electronics students enrolled for the 1993-94 and the 1994-95 school years. The trade school was an extension of the "home" high school. Students attended classes for three hour sessions each day for their vocational requirements then return to their "home" high school. The prerequisites for enrollment into basic electronics was to successfully complete algebra 1 and a placement on the good standing track at his or her "home" high school in preparation for graduation.
Selection of the Sample

The sample used in this study was selected by identifying two preexisting groups from the participating trade school who were enrolled in electronics. Because the samples were not selected randomly, sample size was a priority. To adjust for randomization, both comparison groups contained 30 students each. The sample was limited to those students enrolled at the trade school during school years 1993-95 and 1994-95.

According to Gravetter and Wallnau (1992), and the Central Limit Theorem, for any population with mean $\mu$ and standard deviation $\sigma$, the distribution of sample means for sample size $n$ will approach a normal distribution with a mean of $\mu$ and a standard deviation of $\sigma/\sqrt{n}$ as $n$ approaches infinity. The value of this theorem comes from two simple facts. First, it describes the distribution of sample means for any population, no matter what shape, or mean, or standard deviation. Second, the distribution of sample means “approaches” a normal distribution very rapidly. By the time the sample size reaches $n=30$, the distribution is almost perfectly normal.

Instrumentation

Teacher-made tests were used as the sole measurement device for the degree of learning of students in this study. “Classroom tests play a central role in the evaluation of pupil learning. They provide relevant measures of many important learning outcomes and indirect evidence concerning others.
The validity of the information they provide, however, depends on the care that goes into the planning and preparation of the tests “(Gronlund and Linn, 1990).

**Validity**

Gronlund and Linn (1990) also stated that the strongest case for validity can be made when evidence from the following three categories are understood by the teacher: (a) The test content and the specification it was derived from; (b) The relation of the test scores to other significant measures; and (c) The nature of the characteristic(s) being measured. Interpretation of test scores are likely to have greater validity when the above categories are followed.

The teacher at the participating school used an objective item checklist similar to the one devised by Mager (1984) to ensure test(s) validity.

**Reliability**

"Next to validity, reliability is the most important characteristic of evaluation of results. Reliability (a) provides the consistency that makes validity possible and (b) indicates how much confidence we can place in our results “(Gronlund and Linn, 1990).

This study did not calculate a reliability coefficient, however, the researcher was informed of prior reliability measures conducted before the research by the teacher. This assumption was addressed in Chapter 1.
Collection of the Data

A description of the research protocol was submitted to and approved by the University of Nevada, Las Vegas Institutional Review Board (IRB) and subsequently to the cooperating school district for review and approval.

Data Collection

The data for this study was furnished by the electronics teacher at the school studied. Data that was needed for the study was computerized which expedited the data collection process. Computerized files and hard copies (APPENDIX A and B) of the data were retrieved and given to the researcher. Numerous meetings between the researcher and the teacher followed to confirm all data before hypothesis testing began.

Procedures of the study

The procedures for this study is best presented in a consecutive alpha-format. This format includes: (a) Collect test scores from the respective nine week session; (b) compare content on chapter tests with the respective text book (12 from the expository group and 12 from the computer aided-mastery learning group); (c) compare the test items of each test to each objective intent; and (d) examine extraneous variables such as age, sex, race, high school attended, number of absents and number of times the mastery students took a particular chapter test for reasonable rival hypotheses.
To further analyze how the data were derived, two abbreviated lesson designs, one for 1993-94 and one for 1994-95 were both examined. They are as follows:

**Mastery Group 1994-95**

(1) Materials were divided into small units and covered until mastered.

(2) Instruction was in four stages:

   a. Expository instruction
   
   b. Formative test A on a computer
   
   c. Corrective exercise on a computer
   
   d. Formative test B on a computer

**Steps of delivery**

(1) Expository.

(2) Computer assignments and applications.

(3) After each unit on the computer, a unit test was administered on the computer. If students gave three incorrect responses the computer would lock-up, and place a warning on the screen to notify the instructor. This action is designed to ensure proper monitoring of the students without looking over the students' shoulders.

(4) Mastery/Non-mastery

   a. Those students who did not attain 80 percent or higher mastery on the computer were given corrective computer exercises or reviews designed to help them identify their errors.
b. Those who demonstrated mastery were given enrichment opportunities, which also included tutoring their fellow classmates who needed help.

c. For those who did not attain 80 percent or better after they completed the corrective exercises, a parallel formative computerized test was given. Steps a through c were repeated until 80 percent was achieved.

d. At the end of each chapter a written teacher-made test was administered.

e. If students at this point did not achieve an 80 percent on the chapter test they were given an equivalent test and the average of the two or more tests were used to determine their grade for the chapter.

Expository Group:

(1) Expository instruction
(2) Computer or electronics assignments
(3) Home work
(4) Review
(5) Chapter test (teacher made)
(6) Steps 1, 2, 3, and 4 were repeated on each subsequent chapter until the course was completed

The above abbreviated instructional designs are not all inclusive, however the core of each instructional method was highlighted.
To ensure that the tests used for the 1993-94 school year were comparable to the tests used for the 1994-95 school year, a 30 question checklist was used to compare the two sets of tests items (APPENDIX E). In addition to the 30 question checklist, a content analysis was done, which compared both sets of tests (1993-94 and 1994-95) to the objective that was covered for the particular chapter. The analysis indicated that the 1993-94 tests were equivalent to the 1994-95 tests.

**Data Analysis**

The raw data collected from the electronics teacher were transformed and processed via computer at the University of Nevada, Las Vegas.

The primary statistic used to determine whether or not means from two different samples were different beyond what would be expected due to sample-to-sample variation was a t-test (Slavin, 1984).

The hypothesis was tested using two independent t-tests. An independent t-test was conducted to compare the first quarter (first week in September to mid-November) performance of each respective student. The results of the first set of tests were designed to serve as a baseline for the next quarter. A second independent t-test was conducted to compare the same set of students for the second quarter (mid-November to the end of January) achievements. The need to conduct two independent t-tests was a decision by the researcher to examine the results over a period of time.
The algorithm for the t-tests was located and manipulated by the Statistical Package of Social Science (SPSS) (computer program) also located on the main frame at the University of Nevada, Las Vegas. Detailed descriptive statistics were gathered which included, means, standard deviations, standard errors, and degrees of freedom.

An alpha level of .05 was set for rejecting the null hypothesis (two-tailed).

Summary

The methods employed in this study were determined to be the best for this type of research. The scores of previous tests were useful enough to establish a comparison of the two teaching methods.

The two factors used to determine significant differences between the means were teaching method and learning over time. The other factors that could have been confounding were ruled out due to the fact that all students passed algebra 1 and were on track for graduation. In addition, they were screened and selected for the program using the above criteria. Factors such as age, sex, "home" high school were are also ruled out.

The findings of this study, including analysis and interpretation of the data are presented in Chapter 4.
CHAPTER 4

PRESENTATION OF THE FINDINGS

This study examined two instructional teaching methods with intentions of identifying alternative ways to teach basic electronics. The first teaching method, expository, which was the previous method used at the school was examined using first and second quarter student scores on chapter tests for the 1993-94 school year. The second method, computer aided instruction using a mastery learning format was examined via first and second quarter students scores on chapter test for 1994-95 school year.

The purpose was to ascertain the differences between two teaching methods, and the degree of learning of basic electronics students enrolled at the participating trade school.

Initial Sampling

A total of 30 students of a population of 38 were selected as part of the expository group by means of simple random format. Thirty students were used on the basis of researcher choice and a means of equalizing student numbers for both groups. A total of 30 students of a population of 30 were selected as part of the mastery group on the basis that 30 was the chosen number for sample size.

Table 1 list the 14 “home” high schools that students attended while enrolled in the basic electronics program at the technical trade
school. The table also identifies the distribution of the students in relationship to their "home" high school.

Table 1

Break Down of the Sample by "Home" High School

<table>
<thead>
<tr>
<th>SCHOOL</th>
<th># OF STUDENTS</th>
<th>% OF THE GROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td>H.S. # 1</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>H.S. # 2</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>H.S. # 3</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>H.S. # 4</td>
<td>5</td>
<td>8%</td>
</tr>
<tr>
<td>H.S. # 5</td>
<td>11</td>
<td>18%</td>
</tr>
<tr>
<td>H.S. # 6</td>
<td>5</td>
<td>8%</td>
</tr>
<tr>
<td>H.S. # 7</td>
<td>6</td>
<td>10%</td>
</tr>
<tr>
<td>H.S. # 8</td>
<td>3</td>
<td>5%</td>
</tr>
<tr>
<td>H.S. # 9</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>H.S. # 10</td>
<td>4</td>
<td>7%</td>
</tr>
<tr>
<td>H.S. # 11</td>
<td>1</td>
<td>2%</td>
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<tr>
<td>H.S. # 12</td>
<td>6</td>
<td>10%</td>
</tr>
<tr>
<td>H.S. # 13</td>
<td>10</td>
<td>17%</td>
</tr>
<tr>
<td>H.S. # 14</td>
<td>5</td>
<td>8%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>14</td>
<td>100%</td>
</tr>
<tr>
<td>n=60</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Data Analysis

The dependent variable was measured at two different intervals over the course of the year. Six teacher-made chapter tests were administered (one per chapter) at the end of each chapter which covered the first quarter. The means of the six tests were tabulated and were assigned as the quarter grades. An independent t-test was then used to determine whether the chapter means of the mastery group and expository group were significantly different from each other. The t-tests were conducted twice to compare the first quarter means and second quarter means of each group.

The results of the first quarter comparison are shown in Table 2. Comparison of the mastery learning group means to the expository group means for quarter one revealed no significant differences $t(58) = 1.71$, $p > .05$, two tailed. Therefore the null hypothesis was not rejected for the first quarter.

The results of the second quarter are shown in Table 3. The comparison of the second quarter indicated a significant difference in the means, $t(58) = 4.12$, $p < .05$, two tailed. The null hypothesis was rejected for the second quarter.

### Table 2

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of cases</th>
<th>Mean</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expository</td>
<td>30</td>
<td>79.19</td>
<td>2.28</td>
</tr>
<tr>
<td>Mastery</td>
<td>30</td>
<td>84.08</td>
<td>1.71</td>
</tr>
</tbody>
</table>
Table 3
T-test of Mastery and Expository Group Second Quarter

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of cases</th>
<th>Mean</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expository</td>
<td>30</td>
<td>66.46</td>
<td>3.78</td>
</tr>
<tr>
<td>Mastery</td>
<td>30</td>
<td>83.20</td>
<td>1.49</td>
</tr>
</tbody>
</table>

Summary

The findings of the study were reported in this chapter. The Chapter began with a brief discussion of the purpose of the study and was followed by the initial sampling technique. The 14 high schools that had student representatives who were enrolled at the participating school was then outlined.

Statistical analysis of the hypothesis was also reported in this chapter. The null hypothesis was not rejected for the first quarter; there was no significant difference at the .05 level between the expository group and the
mastery group. However, the null hypothesis was rejected for the second quarter; a significant difference at the .05 level was detected between the expository group and the mastery group.
CHAPTER 5
SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

This study examined two instructional methods which were used to teach electronics at a technical trade school. The first teaching method, expository, a method by which students are taught to memorize facts and then repeat those facts one of two ways (a) orally, or (b) by means of written test. The expository method was used for a number of years and became questionable by the instructor. He felt that there was a need for another method which would bridge the gap between what was learned in school and future work experiences. The method he decided to try was computer aided mastery learning.

The mastery learning method consisted of built-in indicators and ongoing feedback to better monitor learning. The new method used computers to foster self-directed learning and discipline in the electronics field. The new instructional method became an experiment to see if it could replace the present instructional method (expository) and provide better instruction which in turn would graduate better students. Both programs were on the same time scheduled Monday to Friday with three hours per class session and designed to instruct 11th and 12th grade high school high students who were enrolled in basic electronics.
The review of literature suggested that more research was needed to guide specific programs toward a common objective. Although numerous research has been conducted on mastery learning the uniqueness of computer aided mastery learning, in electronics, needed to be explored further. The need to examine and synthesize computer-aided mastery learning was the seed from which this research grew.

**Summary of Purpose and Procedures**

**The Purpose**

The purpose of this study was to identify which instructional method (expository or mastery) is likely to be more effective than the other. It was designed to track the progress of students who were enrolled in basic electronics at an area trade high school.

**The Instruments**

The results of a total of 24 teacher made tests administered to students were used as data for this study (APPENDIX C and D). Each test was constructed to measure the knowledge of a particular chapter (twelve chapters total). There were six chapter tests administered during each quarter to each group. The means of the tests were used for data analysis.

**The Sample**

The sample consisted of 11th and 12th grade students enrolled in basic electronics at the participating school for the 1993-94 and 1994-95 school years. Of the 67 students who were enrolled in the program for the
The respective years 60 were selected using a simple random sampling format (selection and replacement of student numbers from a plastic container).

The Data Collection

Data for the study were collected at different times after the second quarter of the 1994-95 school year. The first meeting with the electronics instructor was to establish anonymity of the students. After approval from the cooperating school district and the University of Nevada, Las Vegas Institutional Review Board, the data were collected in three phases: (a) phase one, collection of all raw scores for each group; (b) phase two, collection of all tests used to generate the raw scores; (c) phase three, verification of raw scores with the instructor before testing the hypothesis.

The Data Analysis

The means for quarter one and two were inputted and saved into the Pico editor program located on the main frame at the University of Nevada, Las Vegas. The means were printed and checked against the original means once more before final analysis. The means were then imported into the Statistical Package of Social Science (SPSS) and compared by means of two independent t-tests, one for each quarter.

Summary of the Findings

This study had student representation from fourteen different high schools in the selected school district which were subdivided into two
discrete groups (expository and mastery). There was one null hypothesis tested at two different intervals (quarter one and quarter two).

**Comparative Data Between Expository Group and Mastery Group for**

**Quarter One**

The statistical results of the first quarter revealed no significant difference between the two instructional methods $t(58) = 1.71, P > .05$, two tailed. The mean of the first quarter were: expository group = 79.19, master group = 84.08 a difference of 4.89.

**Comparative Data Between Expository Group and Mastery Group for**

**Quarter Two**

The statistical results of the second quarter were different from the first. There were significant differences between the two instructional methods which lead the researcher to reject the null hypothesis for the second quarter $t(58) = 4.12, p < .05$, two tailed. The means of the second quarter were: expository group = 66.46, master group = 83.20 a difference of 16.74.

**Conclusion**

As a result of the findings outlined in the preceding section, the following conclusions with regards to the research question delineated in Chapter 1 have been made.

**Research Question One**

Do differences exist in the degree of learning attained by students measured by teacher-made tests?
As a group, the mastery learning students out-performed the expository students. There appears to be differences in the degree of learning between the expository group and the mastery group who participated in this study. Degree of learning was measured by how well students performed on twelve teacher made tests. Means of the twelve tests indicated better performance level for the mastery group. The first quarter results did not indicate a significant difference between the two groups. However, the first quarter results may be due to the level of difficulty of the first quarter content. The topics presented in the first quarter were limited to basic definitions of electrical terms. The first quarter consisted of the necessary vocabulary, which was needed to understand the concepts in the second and subsequent quarters.

The second quarter test results, however, indicated a significant difference between the two groups. It appears as though, when the content progressed from introductory concepts such as, resistive components, series circuits, and Direct Current to parallel circuits, series-parallel circuits, network analysis and Alternating Current, the performance of the mastery group remained about the same (high). However, the expository group performance level decreased, for instants their mean score drop from a 79.19 to 66.46. According to Guskey (1985) mastery learning significantly improves students mastery of higher level skills. In addition he also claimed that, with components like feedback and correctives built into mastery learning, it
improves students ability to solve difficult problems. The findings of this study tends to favor the mastery learning group.

**Research Question Two**

Is there enough time at a vocational high school to practice mastery learning?

Time is one of the on-going hurdles of mastery learning in high school. However, this study did not find any inherent time problems. There was a recommended time schedule available to all students, but most of the students were way ahead of the schedule. The students, who did not pass their chapter test the firsts time, were helped by the students, who did passed their chapter test. This study revealed that three hours per day in a vocational setting appears to be enough time to practice mastery learning.

**Research Question Three**

Do differences exist in the amount of learning?

Again the findings tend to favor the mastery group. The mean score for the expository group for the first quarter was 79.19. The mastery group mean for the same quarter was 84.08. The second quarter mean for the expository was 66.46. The mastery group mean was 83.20.

The mastery group scores, as a group, were consistent throughout the entire study. However, the expository group scores, as a group, shifted from high to low, within the group. To reiterate, the transition from series
direct current circuits to complex alternating current circuits seemed to significantly decrease the performance level of the expository group. The scores of the mastery group suggests that the mastery group functioned more like one cohesive unit or class. The expository group scores on the other hand, suggests that the group had more independent students, which caused the scores to vary more. For this study, if amount of learning can be estimated from scores attained on each chapter test, the findings would suggest that the mastery group acquired or remembered more information than the expository group.

Implications

The findings of this study have at least three major implications. The first is evaluative, comparative data for the specific program studied. This study provided outside assessment which was needed to help the instructor make future decisions in regard to whether or not the program should continue to be taught way using CAI mastery learning. It will also established a reference point for future programs. Second, the manufacture of the computer software program (Heathkit) and similar software producers may use the information obtained to help evaluate how their programs are working out in the field. This will give them additional feedback so they can better service their customers. Third, the results could be valuable if made available to school administrators so they can make future decisions about funding similar instructional programs.
Recommendation for Further Research

As a follow up to the findings in this study the following areas should be researched further:

a. This study should be replicated and studied for the entire school year to monitor if there are increases in the degree of learning as the content level becomes more difficult.

b. A similar study should be conducted to compare other vocational subjects which use the same or similar programs.

c. A follow-up study should be done to track the students who graduate from this program and pursue electronics as a career.

d. Another comparative study should be done comparing the computer aided-mastery learning approach to another instructional method, and then comparing the results with the results found in this study.

e. A similar study should be conducted to compare academic subjects which use a similar program.

To better serve the educational community more studies are needed to examine new and/or unique programs so practitioners of those programs can truly assess accurately whether or not their programs are achieving what they intended them to achieve. This study was based on the above premise.
APPENDIX A

Mean Scores and Other Descriptors of the Expository Group
## Mean Scores and other Descriptors of the Expository Group Quarter 1

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APPENDIX B

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APPENDIX C

Chapter Tests used with the Expository Group
FILL THE BLANK:

1. Like electric charges __________ each other.
   (5)

2. VALENCE electrons are at a __________ (HIGHER/LOWER) energy level than are FREE electrons.
   (5)

3. In its stable state, an Atom will have ________ electrons if it has 6 protons.
   (5)

4. According to your instructor, __________ is the maximum number of electrons in the outer shell of an atom.
   (5)

5. A semiconductor material has __________ electrons in its outer ring.
   (5)

6. The outer ring of an atom is called the ______________ shell.
   (5)

7. In the term MKSA, the letters stand for:
   M______________ K______________
   S______________ A______________
   (20)

TRUE FALSE (Circle the correct letter): EACH IS WORTH 5 POINTS.

8. An object which has a static charge can possess either more or fewer electrons than protons.
   T F

9. A positive ion is an atom which has given up one or more electrons.
   T F

10. Protons and electrons are found in the NUCLEUS of the atom.
    T F

11. Electrons have a NEGATIVE electrical charge.
    T F

12. Protons have a NEUTRAL electrical charge (no charge).
    T F

13. The valence shell is the INNERMOST electron orbit of an atom.
    T F

14. The mantissa of a number expressed in SCIENTIFIC notation must be between 1 and 999, inclusive.
    T F
15. List each of the metric terms, from $10^{+9}$ to $10^{-12}$, used for engineering notation with its corresponding power of ten.

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16. List TWO uses of static electricity discussed by your text.

A. __________________________________________
B. __________________________________________

(17-31) WRITE EACH NUMBER CONVERTING AS NECESSARY (Each is 5 points):

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15 POINT BONUS: DRAW AND LABEL AN ATOM CONTAINING THREE ORBITS. SHOW THE LOCATION OF THE THREE SUBATOMIC PARTICLES DISCUSSED IN CHAPTER 1 OF YOUR TEXT. LABEL (INDICATE) THE VALENCE SHELL.
1. Draw a schematic diagram of a CKT containing the THREE required parts of a circuit (CKT). IDENTIFY EACH OF THE THREE PARTS.

2. In the diagram you drew above, which part converts energy from electrical to do useful work?

   ANS ____________________________

3. Describe a SCHEMATIC diagram.

   ________________________________________________________________

4. Metal foil traces on an insulated board would be called -ANS-.
   (CIRCLE THE CORRECT ANS).

   A) A wired CKT  B) A printed CKT  C) An integrated CKT  D) A ground CKT

5. DRAW the schematic symbols listed:

   ________________________________________________________________

6. Use POSITIVE and NEGATIVE to fill the blanks. Conventional current flows from ____________ to ____________.

   ________________________________________________________________

7. Name the instrument that is used to measure ONLY current.

   ANS ____________________________

8. DESCRIBE the connections of a meter to a CKT when measuring the voltage drop across a resistor.

   ________________________________________________________________
9. When making a/an -ANS- measurement in a CKT you must make sure that the power to the CKT is turned off when making the measurement.

   ANS ________________________________
   (VOLTAGE/CURRENT/RESISTANCE/POWER)

10. DRAW a CKT containing a BATTERY, a RESISTOR, and a SPST SWITCH. Indicate the Positive terminal of the battery. With an arrow indicate the direction of ELECTRON current flow.

   ________________________________
   (50)

11. List six of the 11 safety rules stated in your TEXT.

   A) __________________________________________
   B) __________________________________________
   C) __________________________________________
   D) __________________________________________
   E) __________________________________________
   F) __________________________________________

12. WRITE ohm's law.

   ANS __________________________

   (10)

13. If 12 coulombs pass a given point in 6 seconds, how many amperes of current is flowing?

   ANS ________________

   (10)

14. If the Current in a CKT increases and you know that the voltage stayed the same, then what must have happened to the resistance.

   ANS ________________

   (10)

BONUS 10 points: Draw the schematic symbol for a coil, a transistor and a transformer. (ALL or NOTHING).

   COIL TRANSISTOR TRANSFORMER

   (150)
POWER (PWR) AND ENERGY -- TEST 3A

SCORE ________________________________________ NAME ________________________

ALL ANSWERS, WHERE APPLICABLE ARE TO BE IN PROPER ENGINEERING FORMAT WITH THE PROPER UNITS SPECIFIED. ALL EFFICIENCY ANSWERS MUST BE IN PERCENTAGE.

1. Work is accomplished when energy -ANS-.

(10) ANS ________________________________________

2. Calculate the PWR for a 120 V energy source that delivers 10 amps.

(10) ANS ________________________________________

3. How much current will be required from a 120 V energy source to produce 1.5 kW of PWR?

(10) ANS ________________________________________

4. Calculate the PWR dissipation of a 2.2 k ohm resistor that drops 12 V.

(10) ANS ________________________________________

5. Knowing that 1 HP = 746 W, calculate how much current a 6 HP motor will draw from a 240 V source.

(10) ANS ________________________________________

THE ENERGY RATE FOR PROBLEMS 6-8 IS $.047 PER KWATT HOUR.

COST = KWATT X HOURS X RATE

6. A personal computer is left on for 60 days. Its PWR consumption is 125 W. How much will the electricity cost?

(10) ANS ________________________________________

7. A space heater is on for 3.5 hours. Its PWR consumption is 1.5 kW. How much will the electricity cost?

(10) ANS ________________________________________

8. An air conditioner runs for 5 hours per day for 30 days. Its PWR consumption when on is 2 kW. How much will the electricity cost?

(10) ANS ________________________________________

9. Calculate the efficiency for a motor if the input is 2000 J and the useful output at the motor shaft is 1500 J.

(10) ANS ________________________________________
10. A motor delivers 2 HP of useful output and requires 2611 W from the energy source. Its efficiency is -ANS-.

ANS __________________________

11. An amplifier delivers 100 W of sound energy to the speakers. It has an input voltage of 120 V and draws 1.25 A of current. Its efficiency is -ANS-.

ANS __________________________

12. A salesman is hoping to sell you an audio amplifier. He tells you that this amplifier is very efficient. It will deliver 150 Watts of sound PWR to the speakers while taking only 150 watts from the energy source. Since you are in the Electronics I class at ATTC you know that the salesman is not being truthful with you. What is wrong with his claim?

ANS __________________________

13. Cells of the same chemical type develop the same -ANS-, regardless of their physical size.

ANS __________________________

14. DEFINE the term SHORT circuit.

ANS __________________________

15. How does a slo-blow fuse differ from a normal-blow fuse in operation?

ANS __________________________

16. DRAW a SERIES CKT with a 5 k ohm (R1), a 15 k ohm (R2) resistors and a battery that delivers 25 V.

ANS __________________________

BONUS: A 12V PWR supply is set to current-limit at 225 mA. What is the smallest value of resistance that can be connected to the supply before it goes into current limiting?

ANS __________________________
ELECTRICAL MATERIALS -- TEST 4A

SCORE ___________________________ NAME ___________________________

(160)

ALL ANSWERS, WHERE APPLICABLE ARE TO BE IN PROPER ENGINEERING FORMAT WITH THE PROPER UNITS SPECIFIED.

1. You must choose the wire for a company project. Your primary concern is that the wire you choose must be able to carry the maximum amount of current. You must choose between AWG 10, AWG 12, and AWG 16 copper wire. The wire you choose for the project is -ANS-.

(10)

ANS ___________________________

2. Leakage current can be a problem in -ANS-.

(5) ANS (Insulators/conductors)

3. Breakdown can occur in a/an -ANS-.

(5) ANS (Insulator/conductor)

4. Siemens per meter is the SI unit of -ANS-.

(10)

ANS ___________________________

5. Commercial and industrial wiring may be placed in metal tubes called -ANS-.

(10)

ANS ___________________________

6. Electronic solder is usually composed of 60% tin and 40% -ANS-.

(10)

ANS ___________________________

7. As a conductor's temperature increases, its resistance -ANS-.

(10)

ANS ___________________________

8. The flux used in electronic soldering must NEVER be -ANS-.

(10)

ANS ___________________________

9. Dry air is rated at a breakdown of 30 kV/cm. The voltage required to jump across a 2.54 cm gap is -ANS-.

(10)

ANS ___________________________

(80)
MATCH each of the following with its picture in FIGURE 1:

(5 points each)

10) UHF MALE ________________
11) DB-25 male ________________
12) Banana plug ________________
13) Tip jack ________________
14) RCA Phono plug ________________

MATCH each of the following with its picture in FIGURE 2:

(25)

15) Twin axial ________________
16) Jacketed twisted pair ________________
17) Multi-paired shielded ________________
18) Coaxial ________________
19) Lamp cord ________________

20. A voltage divider in a television receiver consists of a 6-k ohm, a 3-k Ohm, and 1.5 k Ohm resistors in series. If the total current is 15 mA, the total voltage drop is -ANS-.

ANS ________________

(15)

21. Three resistors are connected in series. R1 has a resistance of 40 ohms. R2 causes a 6 V drop and R3 has a resistance of 120 Ohms. The total voltage across the circuit is -ANS- if the current is 300 mA.

ANS ________________

(15)

BONUS (5 points):

DRAW a graph showing a NEGATIVE temperature coefficient: Include labels.
RESISTIVE COMPONENTS -- TEST 5A

SCORE ........................................ NAME ____________________________

(225)

ALL ANSWERS, WHERE APPLICABLE ARE TO BE IN PROPER ENGINEERING FORMAT WITH THE PROPER UNITS SPECIFIED.

1. Wattage rating when referring to a resistor means -ANS-.

ANS ________________________________________________________________

(10)

2. A fixed resistor is different from a variable resistor in that the variable resistor -ANS-.

ANS ________________________________________________________________

(10)

3. DRAW a linear curve for a 10 kOhm resistor, showing at least TWO positive points and ONE negative voltage point.

(20)

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
</table>

 IDENTIFY THE COLOR BANDS FOR THE FOLLOWING LISTED RESISTORS:

(100)

4. ________ ________ ________ ________ 680 ohm +/- 68 ohms
5. ________ ________ ________ ________ 10 kohm +/- 1000 ohms
6. ________ ________ ________ ________ 5.8 ohm +/- 5%
7. ________ ________ ________ ________ 46 ohm +/- 2.3 ohms
8. ________ ________ ________ ________ .15 ohm +/- 7.5 mOhms

(140)

PAGE -1- RAR
CALCULATE AND LIST THE VALUE FOR EACH OF THE RESISTORS:

<table>
<thead>
<tr>
<th>Band 1</th>
<th>Band 2</th>
<th>Band 3</th>
<th>Band 4</th>
<th>Value Including Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>RED</td>
<td>RED</td>
<td>BROWN</td>
<td>GOLD</td>
<td>220 +/- 11 OHMS</td>
</tr>
<tr>
<td>RED</td>
<td>BROWN</td>
<td>BROWN</td>
<td>GOLD</td>
<td></td>
</tr>
<tr>
<td>BROWN</td>
<td>BLUE</td>
<td>BLACK</td>
<td>SILVER</td>
<td></td>
</tr>
<tr>
<td>BROWN</td>
<td>ORANGE</td>
<td>RED</td>
<td>GOLD</td>
<td></td>
</tr>
<tr>
<td>RED</td>
<td>WHITE</td>
<td>GOLD</td>
<td>GOLD</td>
<td></td>
</tr>
<tr>
<td>WHITE</td>
<td>VIOLET</td>
<td>BLUE</td>
<td>SILVER</td>
<td></td>
</tr>
<tr>
<td>GRAY</td>
<td>GREEN</td>
<td>SILVER</td>
<td>GOLD</td>
<td></td>
</tr>
<tr>
<td>RED</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td>SILVER</td>
<td></td>
</tr>
</tbody>
</table>

16. DRAW THE SCHEMATIC SYMBOLS FOR EACH OF THE FOLLOWING:

- FIXED RESISTOR
- POTENTIOMETER
- RHEOSTAT
- THERMISTOR
- MOV
- LDR

17. The larger the physical size of a resistor, the greater its -ANS-.

18. The moving contact in a variable resistor is called the -ANS-.

BONUS: EARN 10 POINTS:

The pots most often used for volume controls are called -ANS-.

ANS
SERIES CIRCUITS -- TEST 6A

SCORE ________________________ NAME ________________________

(270)

ALL ANSWERS, WHERE APPLICABLE ARE TO BE IN PROPER ENGINEERING FORMAT WITH
THE PROPER UNITS SPECIFIED.

1. In a series CKT, when the parameter of -ANS- is found, the technician
knows that it will be the same at all places in that CKT.

ANS ________________________

(10)

2. Go to FIGURE (A) and draw an arrow showing the direction of electron
current flow.

(10)

3. The sum of voltage drops in FIGURE (A) must equal -ANS-.

ANS ________________________

(10)

4. Go to FIGURE (A) and assign polarities to all voltage drops and rises.

(10)

5. Go to FIGURE (B) and draw an arrow indicated the direction of
electron current flow.

(10)

6. One of the batteries in FIGURE (B) is being charged. It is the -ANS-
volt battery.

(5)

7. Go to FIGURE (C) and draw an arrow indicated the direction of
electron current flow.

(10)

8. In the space provided, draw a simplified equivalent CKT for FIGURE
(C).

(10)
9. In FIGURE (E), to set point A to zero volts, the wiper arm would be moved \textit{-ANS-}.

\textbf{ANS} \underline{\hspace{2cm}}

10. The total power dissipated in a series CKT is equal to the \textit{-ANS-} of the individual dissipations.

\textbf{ANS} \underline{\hspace{2cm}}

11. The name for the type of switch shown in FIGURE (H) is \textit{-ANS-}.

\textbf{ANS} \underline{\hspace{2cm}}

12. Suppose the fuse is BLOWN (OPEN) in FIGURE (H). If all the resistors are of the same size, what will be the voltage drop across each resistor?

\textbf{R1} = \underline{\hspace{1cm}} \text{R2} = \underline{\hspace{1cm}} \text{R3} = \underline{\hspace{1cm}}

15

13. Suppose that all the parts in FIGURE (H) are operating normally, and that the switch is OPEN. A voltmeter connected across the switch will indicate \textit{-ANS-} volts.

\textbf{ANS} \underline{\hspace{2cm}}

14. Refer to FIGURE (H). If R2 shorts, the CKT current will be \textit{-ANS-} than normal until the fuse blows.

\textbf{ANS} \underline{\hspace{2cm}}

15. Refer to question 14; what voltage will appear across R2 after it shorts and before the fuse blows?

\textbf{ANS} \underline{\hspace{2cm}}

10

16. If the fuse is blown (open) in FIGURE (H) and the switch is OPEN, the voltage across the fuse will be \textit{-ANS-}.

\textbf{ANS} \underline{\hspace{2cm}}

10

17. \textbf{CALCULATE} each of the following for FIGURE (A).

\textbf{Rt} = \underline{\hspace{1cm}} \text{It} = \underline{\hspace{1cm}}

\textbf{VR 100 ohm} = \underline{\hspace{1cm}} \text{VR 1.5 kOhm} = \underline{\hspace{1cm}}

20
18. Write a loop equation for FIGURE A.

\[ \text{ANS} \]

19. What percentage of voltage will be dropped by the 22 kOhm resistor in FIGURE (D)? (HINT--USE THE VOLTAGE DIVIDER RULE.)

\[ \text{ANS} \]

20. The voltage at point A in FIGURE (E) is from 0 volts to -ANS-.

\[ \text{ANS} \]

21. The POT in FIGURE (E) is a linear taper and is set to the mid-point of its range. The voltage at point A is -ANS-.

\[ \text{ANS} \]

22. Using FIGURE (F), calculate the following:

\[ V_{A-B} = \quad V_A = \quad P_t = \quad V_{D-C} = \quad V_{A-D} = \]

23. The LED in FIGURE (G) drops 1.6 volts. Calculate a size of R that will limit the current flow to 20 mA.

\[ \text{ANS} \]

24. DRAW THE SCHEMATIC SYMBOLS FOR EACH OF THE FOLLOWING:

\[ \text{DPDT SWITCH} \quad \text{SPDT SWITCH} \quad \text{MOMENTARY NORMAL CLOSED} \]

\[ \text{THERMISTOR} \quad \text{FUSE} \quad \text{CELL} \quad \text{RHEOSTAT} \]
PARALLEL CIRCUITS -- TEST 7A

SCORE ____________________________ NAME ____________________________

(200)

ALL ANSWERS, WHERE APPLICABLE ARE TO BE IN PROPER ENGINEERING FORMAT WITH THE PROPER UNITS SPECIFIED.

1. In a parallel CKT, when the parameter of -ANS- is found, the technician knows that it will be the same across all branches that are in parallel with that branch.

   ANS ____________________________

   (10)

2. Using FIGURE (A), calculate each of the following:

   I1 = ___________  I2 = ___________

   (30)

   I2 = ___________  It = ___________

   Rt = ___________  Gt = ___________

3. State Kirchhoffs current law as it applies to parallel CKTS.

   ANS _____________________________________________________________

   (10)

4. The branch with the SMALLEST resistance in a parallel CKT will carry the -ANS- current.

   ANS ____________________________

   (10)

5. The notation R1||R2||R3 indicates -ANS-.

   ANS _____________________________________________________________

   (10)

6. From the CKTS drawn in FIGURE (B) Circle the correct option below.

   (10)

   A) CKT B1 is the correct way to connect two batteries to increase current.
   B) CKT B2 is the correct way to connect two batteries to increase current.
   C) Both CKTs B1 and B2 show the correct way to connect two batteries to increase current.
   D) Neither CKT B1 nor B2 show the correct way to connect two batteries to increase current.
7. Using Figure (C), complete the following table:

<table>
<thead>
<tr>
<th>COMP</th>
<th>VOLTAGE</th>
<th>CURRENT</th>
<th>RESISTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>10 mA</td>
<td></td>
<td>5 kOHMS</td>
</tr>
<tr>
<td>R2</td>
<td></td>
<td>15 mA</td>
<td></td>
</tr>
<tr>
<td>R3</td>
<td></td>
<td></td>
<td>15 kOHMS</td>
</tr>
<tr>
<td>R4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. Using FIGURE (D), determine the size shunt resistor (Rs) required to allow the meter to measure 5 mA.

Rs = \( \frac{20}{9} \) kΩ

9. In the space below, draw an equivalent CKT for FIGURE (A).

\[ \text{(10)} \]

10. Using FIGURE (E), all voltages and currents are shown. What, if anything, is wrong with this CKT?

\[ \text{(10)} \]

ANS: \[ \text{...} \]

11. Using FIGURE (A), each resistor is rated at 1/4 watt. Which resistor or resistors will burn up, if any.

\[ \text{(20)} \]

ANS: \[ \text{...} \]

12. A 120 V circuit has branch loads of 1 kW, 900 W, 400 W, and 250 W. What is the total current flow?

\[ \text{(20)} \]

ANS: \[ \text{...} \]
CHAPTER 10 -- MAGNETISM AND ELECTROMAGNETISM -- TEST 10A
REVISED 9 Dec 93

SCORE:_______________ NAME:____________________

1. The lines of force of a magnetic field are called magnetic -ANS A-.  
ANS_______________

2. The magnetic field is stronger in the middle and weaker at the poles.  
A) TRUE B) FALSE

3. External to the magnet, the direction of flux is from the -ANS A- pole  
to the -ANS B- pole.  
ANS A_______________ ANS B_______________

4. A south pole will -ANS- another south pole.  
ANS_______________

5. When magnetic poles attract each other, at the point of attraction,  
their flux lines flow in the same direction.  
A) TRUE B) FALSE

6. The magnetic field around a current carrying wire has TWO poles.  
A) TRUE B) FALSE

7. The right-hand rule is used to determine the direction of flux around a  
conductor.  
A) TRUE B) FALSE

8. Two parallel conductors -ANS- each other if their currents are flowing  
in the SAME direction.  
ANS_______________

9. Non-magnetic materials like wood and paper PROHIBIT flux from passing  
through them.  
A) TRUE B) FALSE

10. The domains of a TEMPORARY magnet remain aligned after the magnetizing  
force is removed from it.  
A) TRUE B) FALSE

11. DESCRIBE one method used to magnetize a piece of magnetic material.  
__________________________________________

12. Increasing the current or the number of turns of a coil will -ANS- the  
magnetomotive force.  
ANS_______________
13. When a material is saturated, increasing the mmf will INCREASE the flux.
A) TRUE  B) FALSE

14. A temporary magnet has a -ANS- level of residual magnetism.
ANS ________________

15. A material with a -ANS- reluctance would make a good magnetic shield.
ANS ________________

16. The plunger of a solenoid is made from a -ANS- permeability material.
ANS ________________

FOR EACH ITEM GIVEN IN COLUMN 'A' MATCH THE CORRECT UNIT FROM COLUMN 'B'. SOME ANSWERS MAY BE USED MORE THAN ONCE.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>___ 17. mmf</td>
<td>A. Weber</td>
</tr>
<tr>
<td>___ 18. Magnetic field strength</td>
<td>B. Ampere-turn</td>
</tr>
<tr>
<td>___ 19. Flux density</td>
<td>C. Ampere-turn per meter</td>
</tr>
<tr>
<td>___ 20. Magnetic flux</td>
<td>D. Tesla</td>
</tr>
<tr>
<td></td>
<td>E. None of these</td>
</tr>
</tbody>
</table>

21. The element contained in most magnetic materials is --?--.
A. LEAD    B. COPPER    C. TIN    D. IRON

22. When all other factors are equal, the material with the highest permeability will --?--.
A. Have the least reluctance
B. Saturate most easily
C. Have the most residual magnetism
D. Have the lowest flux density

23. The pull of a solenoid is increased by --?--.
A. Forcing less current through the coil
B. Using fewer turns of wire in the coil
C. Using a core material of higher permeability
D. Increasing the air gap around the plunger

24. The invisible lines of force associated with a magnet are known as --?--.
A. Flux       B. Reluctance    C. Permeability    D. Domains
ELECTRIC ENERGY SOURCES -- TEST 11A

FILL THE BLANKS. FOR THE TRUE AND FALSE QUESTIONS, CIRCLE TRUE OR FALSE.

1. The direction of current induced in a conductor can be predicted with the -ANS- generator rule.
   (5) 
   ANS ________________

2. Some rotating generators produce a current flow that periodically reverses. This type of generator produces -ANS- current.
   (10) 
   ANS ________________

3. The output of a rotating machine can be changed from alternating current to pulsating direct current with the use of a/an -ANS- in place of the slip rings.
   (10) 
   ANS ________________

4. Generators may use voltage -ANS- to hold their outputs constant.
   (10) 
   ANS ________________

5. A/An -ANS- cell or battery can be restored by recharging.
   (5) (Primary/Secondary) 
   ANS ________________

6. Define a dry cell.
   (15) 
   ANS ________________

7. The maximum storage time for a cell or battery is called the -ANS-.
   (10) 
   ANS ________________

8. Automobile batteries are of the -ANS- type.
   (10) 
   ANS ________________

9. DEFINE specific gravity.
   (15) 
   ANS ________________

(90) 

PAGE -1- RAR
10. In lead acid cells the specific gravity -ANS- as the cell is CHARGED.

ANS _____________________________

(5) (Increases/Decreases)

11. Describe what is meant by the "memory effect" as it applies to nickel-cadmium cells.

ANS ________________________________________________________________________

(15)

12. Define a photovoltaic cell.

ANS ________________________________________________________________________

(15)


ANS ________________________________________________________________________

(15)


ANS ________________________________________________________________________

(15)

15. Seebeck devices are also known as Piezoelectric materials.

TRUE FALSE

(5)

16. The maximum solar radiation at the earth's surface is 1 kW/m².

TRUE FALSE

(5)

17. Greater cell capacity can be achieved with LOW discharge rates.

TRUE FALSE

(5)

18. Rotating AC machines produce an output that varies as the cosine of the angle of motion.

TRUE FALSE

(5)

19. An electric current can be induced into a conductor if the conductor is held constant and the magnetic field is made to be moving.

TRUE FALSE

(90)

PAGE -2- RAR
CHAPTER 12 -- ALTERNATING CURRENT -- TEST 12A
REVISED -- 23 NOV 90

SCORE __________________________ NAME ________________

CIRCLE THE CORRECT OPTION. YOU MAY WRITE A NOTE CONCERNING YOUR ANSWER FOR ANY QUESTION AND IT WILL BE CONSIDERED IN SCORING YOUR EXAM. WRITE YOUR NOTE NEXT TO THE QUESTION OF CONCERN.

LEGEND: m = milli; μ = micro; n = nano

1. ONE cycle of ac contains --?-- alternation(s).
   A) 1   B) 2   C) 3   C) 4

2. The rate at which ac cycles are produced is referred to as --?--.
   A) Current  B) Cycles  C) Volts  D) Frequency

3. --?-- ALTERNATION(s) per second can be described as 2 Hertz.
   A) 1   B) 2   C) 3   D) 4

4. 255 VAC can be assumed to be 255 volts --?--.
   A) Average  B) RMS  C) PK  D) None of these

5. A conductor rotating in a perfect circle at constant speed in a uniform magnetic field produces a --?--.
   A) Sine wave  B) Square wave  C) Circle wave  D) Ocean wave

6. There are --?-- electrical degrees per alternation and --?-- electrical degrees per cycle.
   A) 360 / 180  B) 120 / 180  C) 180 / 360  D) None of these

7. The rms value of a sine wave is equal to --?-- percent of its peak value.
   A) 63.7  B) 70.7  C) 57.3  D) None of these

8. --?-- is a measure of the number of cycles generated in 1 second.
   A) Period  B) Frequency  C) Hertz  D) Time

9. --?-- is the time in seconds required to complete 1 cycle.
   A) Period  B) Frequency  C) Hertz  D) None of these

10. The --?-- value of a sine wave is LARGER than the effective value.
    A) Peak  B) RMS  C) Average

11. Most electric energy is distributed in the form of a --?-- wave.
    A) Sawtooth  B) Square  C) Sine  D) Pulsating DC
12. The base unit of frequency is the --?--.
   A) Hertz  B) Period  C) Cycle  D) Alternation

13. RMS is the same as --?-- value.
   A) Peak  B) Peak-peak  C) Effective  D) Average

14. A current and voltage waveform are --?-- for a purely resistive CKT.
   A) 90° out of phase  B) in phase  C) Either A or B

15. A square wave has an infinite number of --?-- harmonics.
   A) Odd  B) Even  C) Odd and Even

16. Convert 235 V pk to RMS.
   A) 149.7 V  B) 332.29 V  C) 166.15 V  D) NONE OF THESE

17. Convert 265 acv to pk.
   A) 374.71 V  B) 187.36 V  C) 168.81 V  D) NONE OF THESE

18. Convert 10 V pk-pk to RMS.
   A) 14.14 V  B) 3.54 V  C) 7.07 V  D) NONE OF THESE

19. The rise time of a sawtooth wave is --?-- its fall time.
   A) Equal to  B) Greater than  C) Less than

20. A square wave, centered around zero volts, is a type of --?-- wave.
   A) Pulsating  B) AC  C) Fluctuating dc

21. A square wave has a time of 23 μs. Its frequency is --?--.
    A) 43.5 mHz  B) 43.5 Hz  C) Neither A nor B is Correct

22. A sine wave has a time of 44.5 ms. Its frequency is --?--.
    A) 22.5 Hz  B) 22.5 mHz  C) Neither A nor B is Correct

23. A sine wave has a frequency of 4.56 MHz. Its period is --?--.
    A) 219 ms  B) 219 μs  C) Neither A nor B is Correct

24. It takes 255 ms to produce 16 cycles of ac. The frequency of the signal is --?--.
    A) 62.7 Hz  B) 15.9 mHz  C) Neither A nor B is Correct

25. A --?-- wave has a rise-time equal to its fall-time.
    A) Triangle-wave  B) Saw-tooth wave  C) Neither of these
26. Convert each of the following as indicated:
   A) 236° = ___________ radians
   B) 330° = ___________ π radians
   C) 240 π rads = ___________ degrees
   D) 22.5 radians = ___________ π rads

27. Find the period when the frequency is as indicated.
   A) 120 Hz = ______________
   B) 970 kHz = ______________
   C) 93.3 MHz = ______________

28. Find the frequency when the period is as indicated.
   A) 120 mS = ______________
   B) 970 μS = ______________
   C) 93.3 nS = ______________

BONUS: 10 POINTS. DRAW two SINEWAVES with wave B leading wave A by 90° AND wave B of greater amplitude than wave A.
APPENDIX D

Chapter Tests used with the Mastery Group
If the statement is TRUE write T or True in the provided space. If the answer is FALSE make corrections to the BOLD Word to make the statement true.

1. The acronym MKSA stands for Meter, Kilogram, Second, Ampere.
   Ans. ______________________________________________________________

2. Matter is anything which has weight and occupies space.
   Ans. ______________________________________________________________

3. The valence shell contains electrons that represent the most energy.
   Ans. ______________________________________________________________

4. The Atom is the smallest part into which anything can be divided.
   Ans. ______________________________________________________________

5. Like charges will repel each other when brought close to each other.
   Ans. ______________________________________________________________

6. The electron has a Positive charge.
   Ans. ______________________________________________________________

7. The Proton orbits the nucleus of the atom in the rings.
   Ans. ______________________________________________________________

8. A positive ion has more electrons than protons.
   Ans. ______________________________________________________________

9. A balanced atom has the same number of electrons and protons.
   Ans. ______________________________________________________________
10. **Mega** is the metric prefix that represents $10^{-6}$.

   Ans. ________________________________________________

11. **Milli** is the metric prefix that represents $10^{-3}$.

   Ans. ________________________________________________

12. When an atom gains or loses a **Proton** it is called an ion.

   Ans. ________________________________________________

13. Water is an **element**.

   Ans. ________________________________________________

14. Copper is an **element**.

   Ans. ________________________________________________

15. The lightest element is **hydrogen**.

   Ans. ________________________________________________

16. **Kilo** is the metric prefix that represents $10^3$.

   Ans. ________________________________________________

17. Industry uses electrostatics to **paint** surfaces.

   Ans. ________________________________________________

18. A compound is made of 2 or more **elements**.

   Ans. ________________________________________________

19. A **molecule** is the smallest part of a compound that retains all the characteristics of the compound.

   Ans. ________________________________________________

20. The innermost shell of an atom can contain no more than 4 electrons.

   Ans. ________________________________________________
### Electronics I
TEST – 02A
Current and Voltage

MATCH each term with its definition by placing the ID of the definition in the ANS. for each term. Each is worth 5 points. You may write your own definition and use one of the “Z” options. Write the answer you think defines a term and identify it in the ANS Column.

<table>
<thead>
<tr>
<th>Term</th>
<th>ANS</th>
<th>Definition</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Valence Shell</td>
<td></td>
<td>Electricity produced with Friction</td>
<td>A</td>
</tr>
<tr>
<td>2. Valence Electron</td>
<td></td>
<td>Electricity Produced with Pressure</td>
<td>B</td>
</tr>
<tr>
<td>3. Negative Ion</td>
<td></td>
<td>Electricity produced chemically</td>
<td>C</td>
</tr>
<tr>
<td>4. Conductor</td>
<td></td>
<td>Electricity produced by temperature</td>
<td>D</td>
</tr>
<tr>
<td>5. Piezoelectricity</td>
<td></td>
<td>Electricity produced by light</td>
<td>E</td>
</tr>
<tr>
<td>6. Insulator</td>
<td></td>
<td>An atom with an excess of electrons</td>
<td>F</td>
</tr>
<tr>
<td>7. Photovoltaic</td>
<td></td>
<td>An atom with a deficiency of electrons</td>
<td>G</td>
</tr>
<tr>
<td>8. Semi Conductor</td>
<td></td>
<td>Outer electron orbit of an Atom</td>
<td>H</td>
</tr>
<tr>
<td>9. Battery</td>
<td></td>
<td>Inner electron orbit of an atom</td>
<td>I</td>
</tr>
<tr>
<td>10. Voltage</td>
<td></td>
<td>Electrostatic Pressure</td>
<td>J</td>
</tr>
<tr>
<td>11. Current</td>
<td></td>
<td>Flow of charge carriers</td>
<td>K</td>
</tr>
<tr>
<td>12. Positive ION</td>
<td></td>
<td>An inert gas</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A component of the compound water</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Easily conducts Electricity</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 or more Electrons in Valence Shell</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 or More electrochemical cells</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td></td>
<td>An electron in the outer shell</td>
<td>Q</td>
</tr>
<tr>
<td></td>
<td></td>
<td>An electron in the inner shell</td>
<td>R</td>
</tr>
</tbody>
</table>

|                      |     | Z1                                              |    |
|                      |     | Z2                                              |    |
|                      |     | Z3                                              |    |
|                      |     | Z4                                              |    |
1-4. The simplest form of an electrical circuit (CKT) consists of ANS A, ANS B, ANS C, and ANS D.

ANS A ___________  B ___________  C ___________  D ___________

5-9. Draw the simplest form of a CKT and include the direction of electron current flow.

10-14. Draw the schematic symbols for each of the following:

<table>
<thead>
<tr>
<th>Cell</th>
<th>Resistor</th>
<th>Battery</th>
<th>Lamp</th>
<th>Switch</th>
</tr>
</thead>
</table>

The following statements are true or false. If the statement is true, write TRUE in the answer space. If the answer is FALSE, write the word or words to replace the words in BOLD in the answer space that would make the statement true.

15. A PRIMARY cell is designed to be rechargeable.
ANS ________________________________

16. A WET cell is designed to be used only in the upright position.
ANS ________________________________

17. Batteries can be connected in series aiding to increase the amount of CURRENT available to a CKT.
ANS ________________________________

18. A light will remain lit for 1 hour with one battery. By connecting two batteries in SERIES-AIDING the light will stay lit for 2 hours.
ANS ________________________________

19. Voltage rises are caused by Power sources.
ANS ________________________________
If the statement is TRUE then write T or True in the answer space. If the statement is FALSE then write the word that replaces the BOLD word in the answer space that would make the statement True.

13. DIRECT DRIFT is the term used to describe the random movement of electrons in a conductor without the influence of a voltage.
   ___ ANS. ________________________________________________________________
   (5)

14. The AMPERE is the unit of voltage.
   ___ ANS. ________________________________________________________________
   (5)

15. The symbol for current is C.
   ___ ANS. ________________________________________________________________
   (5)

16. The symbol for Voltage is V.
   ___ ANS. ________________________________________________________________
   (5)

17. Electrons always move from the NEGATIVE PRESSURE TO THE POSITIVE.
   ___ ANS. ________________________________________________________________
   (5)

18. Two dissimilar metals fused together that produce electricity when heated is called a Photocell.
   ___ ANS. ________________________________________________________________
   (5)

19. - 25. Draw a basic simple circuit (CKT) and label the 4 basic parts.
   _______
MATCH each term with its definition by placing the ID of the definition in the ANS. for each term. If you cannot find the correct answer, supply your own in the place provided. You may use up to 4 "Z" answers. Write the definition you think best describes a term and mark the answer in the ANS section.

<table>
<thead>
<tr>
<th>Term</th>
<th>ANS.</th>
<th>Definition</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Resistivity</td>
<td>A</td>
<td>Device used to measure resistance</td>
<td></td>
</tr>
<tr>
<td>2. Resistance</td>
<td>B</td>
<td>Unit of Conductance</td>
<td></td>
</tr>
<tr>
<td>3. Conductance</td>
<td>C</td>
<td>Unit of Resistance</td>
<td></td>
</tr>
<tr>
<td>4. Ohm</td>
<td>D</td>
<td>Resistance of a 1-foot length of wire</td>
<td></td>
</tr>
<tr>
<td>5. Thermister</td>
<td>E</td>
<td>Opposition to current flow</td>
<td></td>
</tr>
<tr>
<td>6. Potentiometer</td>
<td>F</td>
<td>An atom with an excess of electrons</td>
<td></td>
</tr>
<tr>
<td>7. Rheostat</td>
<td>G</td>
<td>An atom with a deficiency of electrons</td>
<td></td>
</tr>
<tr>
<td>8. Semi Conductor</td>
<td>H</td>
<td>Determined by the physical size of a resistor</td>
<td></td>
</tr>
<tr>
<td>9. Mho</td>
<td>I</td>
<td>A variable resistor with three terminals</td>
<td></td>
</tr>
<tr>
<td>10. Ohmmeter</td>
<td>J</td>
<td>Electrostatic Pressure</td>
<td></td>
</tr>
<tr>
<td>11. Current</td>
<td>K</td>
<td>Flow of charge carriers</td>
<td></td>
</tr>
<tr>
<td>12. Wattage</td>
<td>L</td>
<td>A variable resistor with two terminals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>A variable resistor that varies with temperature</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Reciprocal of resistance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>O</td>
<td>5 or more Electrons in Valence Shell</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>4 Electrons in Valence Shell</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Q</td>
<td>2 or More electrochemical cells</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Z1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Z2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Z3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Z4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
20. Current flow is required for a voltage RISE.
ANS

21. In a resistive-series CKT, the voltage rises must equal the voltage drops.
ANS

22. A reference point in a CKT is normally GROUND.
ANS

Using FIGURE 1, write the correct voltage between each of the following points:

<table>
<thead>
<tr>
<th>POINT 1</th>
<th>POINT 2</th>
<th>VOLTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>24.</td>
<td>A</td>
<td>C</td>
</tr>
<tr>
<td>25.</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>26.</td>
<td>B</td>
<td>D</td>
</tr>
<tr>
<td>27.</td>
<td>D</td>
<td>B</td>
</tr>
<tr>
<td>28.</td>
<td>A</td>
<td>D</td>
</tr>
<tr>
<td>29.</td>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td>30.</td>
<td>D</td>
<td>A</td>
</tr>
</tbody>
</table>
MATCH each term with its definition by placing the **ID** of the definition in the **ANS.** for each term. Some definitions may be used more than once. If you cannot find the definition you think describes the term then write your definition above the term and it will be considered. YOU MAY USE A "Z" ANSWER. WRITE THE RESPONSE YOU WANT IN THE SPACE PROVIDED AND MARK THE ANS SPACE AS "Z1", "Z2", ETC. 

**LEGEND:** E.G. = Example Given; CKT = Circuit

<table>
<thead>
<tr>
<th>Term</th>
<th>ANS.</th>
<th>Definition</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Coulomb</td>
<td></td>
<td>A CKT with lower than normal resistance</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A CKT where current cannot flow</td>
<td>B</td>
</tr>
<tr>
<td>2. Scientific Notation</td>
<td></td>
<td>A CKT where voltage cannot flow</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 Coulomb per second</td>
<td>D</td>
</tr>
<tr>
<td>3. Engineering Notation</td>
<td></td>
<td>Electricity produced by light</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>An atom with an excess of electrons</td>
<td>F</td>
</tr>
<tr>
<td>4. Ammeter</td>
<td></td>
<td>E.G. (2.3 X 10^-4)</td>
<td>G</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E.G. (50.4 X 10^-6)</td>
<td>H</td>
</tr>
<tr>
<td>5. Voltmeter</td>
<td></td>
<td>Inner electron orbit of an atom</td>
<td>I</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electrostatic Pressure</td>
<td>J</td>
</tr>
<tr>
<td>6. ohmmeter</td>
<td></td>
<td>An adjustment made to an ohmmeter</td>
<td>K</td>
</tr>
<tr>
<td></td>
<td></td>
<td>An adjustment made to an ammeter</td>
<td>L</td>
</tr>
<tr>
<td>7. Short Circuit</td>
<td></td>
<td>6.25 X 10^-18 electrons</td>
<td>N</td>
</tr>
<tr>
<td>8. Open Circuit</td>
<td></td>
<td>Device used to measure electrical resistance</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Device used to measure electrical current</td>
<td>P</td>
</tr>
<tr>
<td>9. Polarity</td>
<td></td>
<td>Device used to measure electrical pressure</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 or More electrochemical cells</td>
<td>S</td>
</tr>
<tr>
<td>10. Zero Adjust</td>
<td></td>
<td>Z1</td>
<td></td>
</tr>
<tr>
<td>11. Battery</td>
<td></td>
<td>Z2</td>
<td></td>
</tr>
</tbody>
</table>
If the statement is TRUE then write T or True in the answer space. If the statement is FALSE then write the word that replaces the BOLD word in the answer space that would make the statement True.

13. If a wire has a resistance of 100 Ω it will have a conductance of .1 Ohms.
   _____ AN ________________________________

14. The longer a wire is the GREATER Will be its resistance.
   _____ AN ________________________________

15. The symbol for Resistance is R.
   _____ AN ________________________________

16. The symbol for Conductance is C.
   _____ AN ________________________________

17. The greater the cross-sectional area the GREATER will be a materials resistance.
   _____ AN ________________________________

18. If a material’s resistance increases as temperature increases, it is said to have a POSITIVE temperature coefficient.
   _____ AN ________________________________

19. The RESISTANCE of a resistor can be determined by its physical size.
   _____ AN ________________________________

20. A/An VOLTMETER is normally used to measure resistance value of a resistor.
   _____ AN ________________________________

21. The three important resistor ratings are TOLERANCE, WATTAGE, AND CURRENT.
   _____ AN ________________________________
COMPLETE THE FOLLOWING RESISTOR COLOR CHART BY IDENTIFYING THE COLORS THAT REPRESENT THE GIVEN VALUES.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

34 - 36. DRAW the identified schematic symbols.

Resistor | Potentiometer | Rheostat
----------|---------------|---------
R1 = 1 k   |               |         |
R2 = 2 k   |               |         |
R3 = 1 k   |               |         |

37-38. Total Resistance of the circuit at the right is -ANS- ohms.

ANS ____________________

39-40. R1 = 1 k Ω, R2 = 2 k Ω, & R3 = 3k Ω. The total resistance for this circuit is -ANS- ohms.

ANS ____________________
Using Figure 1, R₁ = 2k Ω and R₂ = 3k Ω. V₁ = 10 V.

1. Rᵣ = ______________ ohms.  2. Iᵣ = ______________ Amps.

3 - 4 - 5. Draw a simplified CKT for Figure 1.

Using Figure 1, R₁ = 5 k Ω and R₂ = 10k Ω. Iᵣ = 15 mA.


Using Figure 1, Vᵣ = 20 Volts and Iᵣ = 10 mA.

8. Rᵣ = ______________ ohms.

9. A 100 ohm resistor carries 15 mA of current. The Voltage causing the current to flow through the resistor is -ANS-.

ANS ______________

10. A resistor carries 10 mA of current and drops 150 Volts. The resistance of the resistor is -ANS-.

ANS ______________
12. There is normally only one scale available on an AMMETER.
ANS. ________________________________

13. To measure voltage, the power to the circuit under test must be OFF at the time of the measurement.
ANS. ________________________________

14. To measure current, the power to the circuit under test must be OFF at the time of the measurement.
ANS. ________________________________

15. To measure resistance, the power to the circuit under test must be OFF at the time of the measurement.
ANS. ________________________________

16. To measure voltage, the voltmeter is placed in PARALLEL to the CKT under test.
ANS. ________________________________

17. To measure current, the ammeter is placed in PARALLEL to the CKT under test.
ANS. ________________________________

18. When measuring the resistance of a resistor, polarity DOES NOT have to be observed.
ANS. ________________________________

19. When measuring DC Voltage with an analog meter, polarity DOES NOT have to be observed.
ANS. ________________________________

20. When measuring DC current with an analog meter, polarity DOES NOT have to be observed.
ANS. ________________________________
MATCH THE FOLLOWING TERMS:

<table>
<thead>
<tr>
<th>TERM</th>
<th>ANS.</th>
<th>DEFINITION</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Power</td>
<td>A unit of energy created when 1 volt moves 1 coulomb of charge</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>2. Voltage</td>
<td>The movement of electrons in a circuit</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>3. Dissipation</td>
<td>The measure of electromotive force, or EMF</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>4. Work</td>
<td>When a voltage rise forces electrons through a load</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>5. Watt</td>
<td>The rate at which work is done</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>6. Current</td>
<td>The unit of power</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>7. Joule</td>
<td>The method by which power is released within a circuit</td>
<td>G</td>
<td></td>
</tr>
<tr>
<td>8. Heat</td>
<td>Most common form of power dissipation</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td>No definition listed</td>
<td></td>
<td>I</td>
<td></td>
</tr>
</tbody>
</table>

9. Explain the difference between determining the power for a complete circuit and determining the power of a single component.
Solve for the unknown value.

10. What is the power dissipated in a circuit with 50 volts applied and a total current of 3.2 amps?

11. What is the voltage drop across a light bulb that dissipates 60 watts when the current through the bulb is .5 amps?

12. How much current flows through a 75 watt light bulb which is connected across a 120 volt power line?

13. How much power is dissipated by a 22 ohm resistor if the voltage drop across the resistor is 5 volts?

14. How much power is dissipated by a circuit that has a total of 40 ohms of resistance and .5 amps of current?
Match the following terms with their definitions. Use the Z1 or Z2 options to complete an item with your definition.

<table>
<thead>
<tr>
<th>Term</th>
<th>ANS</th>
<th>Definitions</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Voltage divider</td>
<td>An electrical circuit which has a single path for current flow</td>
<td>A.</td>
<td></td>
</tr>
<tr>
<td>2. Series circuit</td>
<td>A circuit which has two or more paths for current across a single potential</td>
<td>B.</td>
<td></td>
</tr>
<tr>
<td>3. Unbalanced bridge</td>
<td>An electrical circuit where both series and parallel components are used</td>
<td>C.</td>
<td></td>
</tr>
<tr>
<td>4. Bridge network</td>
<td>Device used to measure current in a Wheatstone bridge</td>
<td>D.</td>
<td></td>
</tr>
<tr>
<td>5. Balanced bridge</td>
<td>A circuit which produces a number of smaller voltages with a single source voltage</td>
<td>E.</td>
<td></td>
</tr>
<tr>
<td>6. Series-parallel circuit</td>
<td>Component used as a temperature sensing device</td>
<td>F.</td>
<td></td>
</tr>
<tr>
<td>7. Parallel circuit</td>
<td>A resistive network made up of a pair of resistors in two parallel branches, where an output is available between the resistors within each branch</td>
<td>G.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>When no potential difference or current flow is available across the output terminals of a bridge circuit</td>
<td>H.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>When a potential difference or current flow is available across the output terminals of a bridge circuit</td>
<td>I.</td>
<td></td>
</tr>
</tbody>
</table>

Z1

Z2
8. Draw a series-parallel circuit with a battery and 4 resistors. \( R_2 \) and \( R_3 \) form a parallel network that is in series with \( R_1 \) and \( R_4 \). \( V_T = 30V \). \( R_1 = 10 \, k\Omega \), \( R_2 = 2 \, k\Omega \), \( R_3 = 4 \, k\Omega \) and \( R_4 = 5 \, k\Omega \).

Refer to the circuit in problem #8 to answer the following questions.

9. Resistance of the parallel branch is ___________.

10. Total resistance of the circuit is ___________.

11-14. \( I_{R_1} \) \( I_{R_2} \) \( I_{R_3} \) \( I_{R_4} \)

15-18. \( V_{R_1} \) \( V_{R_2} \) \( V_{R_3} \) \( V_{R_4} \)

23-26. \( P_{R_1} \) \( P_{R_2} \) \( P_{R_3} \) \( P_{R_4} \)

31. Total dissipated power of this circuit is ___________.

32. Draw a series voltage divider circuit with \( V_T = 30V \), \( R_1 = 10 \, k\Omega \), \( R_2 = 5 \, k\Omega \), and \( R_3 = 15 \, k\Omega \). Include a test point A (TPA) at the top of \( R_1 \), TPB between \( R_1 \) and \( R_2 \), and TPC between \( R_2 \) and \( R_3 \).

Refer to the circuit in problem #32 to answer the following questions.

33. \( R_T \) \( I_T \)

35. \( V_{TPC} \) \( V_{TPB} \) \( V_{TPA} \)
38. Draw a bridge circuit with \( V_T = 30V \). Branch 1 consists of \( R_1 \) and \( R_2 \), Branch 2 consists of \( R_3 \), and \( R_4 \). Label output terminals and include a voltmeter in the circuit.

Determine the value of the resistor needed to insure the bridge is balanced.

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>( R_1 )</td>
<td>( R_2 )</td>
<td>( R_3 )</td>
<td>( R_4 )</td>
</tr>
<tr>
<td>22. 1 Kohm</td>
<td>1 Kohm</td>
<td>1 Kohm</td>
<td></td>
</tr>
<tr>
<td>23. 1 Kohm</td>
<td>2 Kohm</td>
<td></td>
<td>20 Kohm</td>
</tr>
<tr>
<td>24. 100 ohm</td>
<td></td>
<td>100 ohm</td>
<td>500 ohm</td>
</tr>
<tr>
<td>25.</td>
<td>3 Kohm</td>
<td>2 Mohm</td>
<td>6 Mohm</td>
</tr>
</tbody>
</table>

If the statement is TRUE then write T or True in the answer space. If the statement is FALSE then write a word or words that replaces the BOLD section in the answer space that would make the statement True.

26. The function of a bridge circuit is to take one voltage source and obtain a number of different voltages.
ANS. ________________________________________________________________

27. The output terminals of a bridge circuit usually have a voltmeter or an ammeter connected between them.
ANS. ________________________________________________________________

28. A balanced bridge circuit is one in which the voltage measured between the two output terminals is 0 volts.
ANS. ________________________________________________________________

29. If the ratio between \( R_1 \) and \( R_2 \) is less than the ratio between \( R_3 \) and \( R_4 \), the bridge is balanced.
ANS. ________________________________________________________________
30. The wheatstone bridge is used to measure voltage.
ANS.______________________________________________________________

31. If one of the resistors in a bridge circuit is replaced with a thermistor, the bridge can be used as a light sensor.
ANS.______________________________________________________________

32. Kirchoff's Voltage Law states _________________________________________

33. Kirchoff's Current Law states _________________________________________
Match the following terms with their definitions. To use one of the Z-options, write the definition in the space provided and select that ID for the ANS.

<table>
<thead>
<tr>
<th>TERM</th>
<th>ANS</th>
<th>DEFINITION</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reluctance</td>
<td></td>
<td>The region of magnetic influence surrounding a material</td>
<td>A</td>
</tr>
<tr>
<td>2. Flux density</td>
<td></td>
<td>Materials surrounded by a magnetic field in their natural state</td>
<td>B</td>
</tr>
<tr>
<td>3. Permanent magnet</td>
<td></td>
<td>Materials which have a magnetic field transferred onto them</td>
<td>C</td>
</tr>
<tr>
<td>4. Retentivity</td>
<td></td>
<td>Materials which maintain their magnetic fields for long periods of time</td>
<td>D</td>
</tr>
<tr>
<td>5. Permeability</td>
<td></td>
<td>The particles of an atom most effected by magnetic forces</td>
<td>E</td>
</tr>
<tr>
<td>6. Magnetic Field</td>
<td></td>
<td>Lines of magnetic force surrounding a magnet</td>
<td>F</td>
</tr>
<tr>
<td>7. Natural magnet</td>
<td></td>
<td>The number of flux lines per unit of area</td>
<td>G</td>
</tr>
<tr>
<td>8. Magnetic induction</td>
<td></td>
<td>The ease with which a material can accept lines of force</td>
<td>H</td>
</tr>
<tr>
<td>9. Artificial magnet</td>
<td></td>
<td>Like poles repel; opposite poles attract</td>
<td>I</td>
</tr>
<tr>
<td>10. Flux lines</td>
<td></td>
<td>The action which induces a current flow in a conductor when the conductor moves through a magnetic field</td>
<td>J</td>
</tr>
<tr>
<td>11. Electromagnetic induction</td>
<td></td>
<td>The ability to induce a magnetic field into a nonmagnetized object</td>
<td>K</td>
</tr>
<tr>
<td>12. Temporary Magnet</td>
<td></td>
<td>The magnetic field remaining within a temporary magnet after removal of a permanent magnet</td>
<td>L</td>
</tr>
<tr>
<td>13. Residual Magnetism</td>
<td></td>
<td>Opposition to flux; the reciprocal of permeability</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Materials which quickly lose their magnetism</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The ability of a material to retain a magnetic field</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Z1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Z2</td>
</tr>
</tbody>
</table>
Define the following terms: Use one of the "Z" options to supply your own answer.

<table>
<thead>
<tr>
<th>TERM</th>
<th>ANS</th>
<th>DEFINITION</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Induction</td>
<td></td>
<td>The action of a conductor inducing CEMF into itself when there is a change of current in the conductor</td>
<td>A</td>
</tr>
<tr>
<td>2. Capacitance</td>
<td></td>
<td>The state of a circuit where current has reached the value computed by Ohm's Law</td>
<td>B</td>
</tr>
<tr>
<td>3. Steady state</td>
<td></td>
<td>The release of the stored potential of a capacitor</td>
<td>C</td>
</tr>
<tr>
<td>4. Polarized</td>
<td></td>
<td>Another term for an inductor</td>
<td>D</td>
</tr>
<tr>
<td>component</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. CEMF</td>
<td></td>
<td>The action of inducing CEMF with a change in current</td>
<td>E</td>
</tr>
<tr>
<td>6. Time</td>
<td></td>
<td>The ability of a circuit or component to oppose any change in current</td>
<td>F</td>
</tr>
<tr>
<td>constant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Farad</td>
<td></td>
<td>The unit of measurement for inductance</td>
<td>G</td>
</tr>
<tr>
<td>8. Self-induction</td>
<td></td>
<td>The ability of a device to store electrical energy by means of a electrostatic field</td>
<td>H</td>
</tr>
<tr>
<td>9. Inductance</td>
<td></td>
<td>The insulating material between the 2 plates of a capacitor</td>
<td>I</td>
</tr>
<tr>
<td>10. Dielectric</td>
<td></td>
<td>The unit of capacitance</td>
<td>J</td>
</tr>
<tr>
<td>11. Transient</td>
<td></td>
<td>A device having a positive and a negative lead</td>
<td>K</td>
</tr>
<tr>
<td>state</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Henry</td>
<td></td>
<td>The amount of time for one interval of the transient time</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Induced current caused by an induced EMF</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The state of a circuit where current is building up to its steady state value</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
13. The schematic symbol for an air core inductor is ___________________ and the schematic symbol for an iron core inductor is ___________________.

14. Inductance is represented by the letter _____.

15. An inductor opposes a change in _______ _______.

Name 2 ways to increase the inductance of a coil (inductor).

16. ________________________________

17. ________________________________

18. Theoretically, it will take ________ time constants for the current/voltage to reach its full value.

19. Current/voltage reaches _________ percent of its maximum value at the end of the first time constant.

20. During each succeeding time constant, current/voltage increases by what value? ________________________________

21. The schematic symbol for a capacitor is _____________________.

22. Capacitance is represented by the letter _______.

23. How does the size of the plates (plate area) affect capacitance? _________

24. How does the distance between the plates affect capacitance? _________

25. How does the dielectric constant affect capacitance? _________________

26. One of the most important capacitor types is the electrolytic. Describe its construction. ________________________________

27. Extreme CAUTION should be used with capacitors. In the interest of safety you should always check capacitors for ________________ and _________________.


28. The formula to determine the time constant of an inductive circuit is

29. The formula to determine the time constant of a capacitive circuit is

30. What is the total inductance of a circuit with a 5 millihenry inductor in series
    with a 10 millihenry inductor? _______________

31. What is the total inductance of a circuit with a 10 millihenry inductor in
    parallel with a 25 millihenry inductor? _______________

32. What is the total capacitance of a circuit with a 25 microfarad capacitor in
    series with a 50 microfarad capacitor? _______________

33. What is the total capacitance of a circuit with a 15 microfarad capacitor in
    parallel with a 20 microfarad capacitor? _______________
# Electronics I
## Test -- FE - 11
### Introduction to AC

Score: ____________  Name: __________________

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Alternating Current</td>
<td></td>
</tr>
<tr>
<td>2. Sine Wave</td>
<td></td>
</tr>
<tr>
<td>3. Cycle</td>
<td></td>
</tr>
<tr>
<td>4. Alternation</td>
<td></td>
</tr>
<tr>
<td>5. Instantaneous Value</td>
<td></td>
</tr>
<tr>
<td>6. Peak Value</td>
<td></td>
</tr>
<tr>
<td>7. Effective Value</td>
<td></td>
</tr>
<tr>
<td>8. Average Value</td>
<td></td>
</tr>
<tr>
<td>9. Period</td>
<td></td>
</tr>
<tr>
<td>10. Frequency</td>
<td></td>
</tr>
<tr>
<td>11. Hertz</td>
<td></td>
</tr>
<tr>
<td>12. Wattage</td>
<td></td>
</tr>
</tbody>
</table>

**WRITE** the definition of each term next to the term.

13. As the Strength of a magnetic field increases the current induced will **DECREASE**.

14. A conductor cutting a magnetic field at $85^\circ$ will have a **GREATER** current induced than a conductor cutting the field at $65^\circ$.
15. One cycle of AC is made up of **TWO POSITIVE** alternations.

16. One cycle of AC contains **180 electrical degrees**.

17. **DRAW** one cycle of AC and label the position of each of the following: A-Peak Value, B-Average Value, and C-RMS Value.

Complete the following table:

<table>
<thead>
<tr>
<th>RMS</th>
<th>Peak</th>
<th>Peak - Peak</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-23.</td>
<td>75 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24-26.</td>
<td>100 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27-29.</td>
<td></td>
<td>20 V</td>
<td></td>
</tr>
<tr>
<td>30-32.</td>
<td></td>
<td></td>
<td>65 V</td>
</tr>
</tbody>
</table>

33. An AC signal is at a frequency of 130 kHz. Its period is ________________.
Match the following terms with their definitions. You may use one of the Z options to supply your answer to a given definition. You may use no more that 4 Z options.

<table>
<thead>
<tr>
<th>Term</th>
<th>ANS</th>
<th>Definitions</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Graticule</td>
<td></td>
<td>A circuit that produces the VERTICAL input signal to the Vertical Deflection Plates</td>
<td>A</td>
</tr>
<tr>
<td>2. Lissajous Pattern</td>
<td></td>
<td>A grid that is on the face of the CRT. Normally contains a grid of 1 cm squares.</td>
<td>B</td>
</tr>
<tr>
<td>3. CRT</td>
<td></td>
<td>The plates that receive a SAWTOOTH wave, generated by the circuitry of the o'scope.</td>
<td>C</td>
</tr>
<tr>
<td>4. Sweep Oscillator</td>
<td></td>
<td>The time of one cycle of a signal; often an AC signal.</td>
<td>D</td>
</tr>
<tr>
<td>5. Electron Gun</td>
<td></td>
<td>A signal displayed on the o'scope that is produced by combining two input signals.</td>
<td>E</td>
</tr>
<tr>
<td>6. Horizontal</td>
<td></td>
<td>The source of the electron beam.</td>
<td>F</td>
</tr>
<tr>
<td>Deflection Plates</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Phase Relationship</td>
<td></td>
<td>The plates that receive the input signal.</td>
<td>G</td>
</tr>
<tr>
<td>8. Vertical Deflection Plates</td>
<td></td>
<td>A circuit that produces the TRIANGLE wave that moves the electron beam horizontally on the face of the CRT.</td>
<td>H</td>
</tr>
<tr>
<td>9. Period</td>
<td></td>
<td>The frequency of the signal being displayed on the O' scope.</td>
<td>L</td>
</tr>
</tbody>
</table>

The following are TRUE / FALSE questions. If the statement is true, write true in the answer box. If the statement is false, cross out the BOLD WORD(S) and replace them with the word(s) that will make the statement true.

10. When measuring current with an analog meter, you must observe polarity when measuring DC.
    
    ANS ______________________________________________

11. Breaking the circuit is one of the steps you use when measuring VOLTAGE.
    
    ANS ______________________________________________

12. An AC voltmeter displays the sinewave voltage measured as AVERAGE.
    
    ANS ______________________________________________

13. An AC CURRENT METER shows a picture of the wave being measured.
    
    ANS ______________________________________________
14. In an O'scope, the input signal (Signal being measured) is sent to the VERTICAL DEFLECTION plates.
ANS

15. The sweep oscillator produces a TRIANGLE wave.
ANS

16. The VERTICAL axis on the face of the CRT is a measure of the time of a cycle.
ANS

17. An AC signal has a peak value of 20 Amps. A current meter connected to this CKT would indicate a current of 20 AMPS.
ANS

18. AC voltmeters DO NOT provide true RMS readings when the waveform is nonsinuosoidal.
ANS

19. The HORIZONTAL deflection plates receive the sawtooth sweep signal.
ANS

20. The grid pattern on the face of the CRT is referred to as the GRADIENT.
ANS

Using the FIGURE above, complete the table:

<table>
<thead>
<tr>
<th>Horizontal Time/cm</th>
<th>Vertical V/cm</th>
<th>Period</th>
<th>Frequency</th>
<th>Pk-Pk</th>
<th>RMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-22.</td>
<td>.2 mS</td>
<td>.5 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23-26</td>
<td>10 μS</td>
<td>20 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27-30.</td>
<td>50 μS</td>
<td>5 mV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31-34.</td>
<td>1 mS</td>
<td>.05 V</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX E

Test Items Checklist
### TESTS ITEMS CHECKLIST

<table>
<thead>
<tr>
<th></th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Can the items be answered with a number, symbol, word, or brief phrase?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>2. Has textbook language been avoided?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>3. Have the items been stated so that only one response is correct?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>4. Are the answer blanks equal in length?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>5. Are the answer blanks at the end of the items?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>6. Are the items free of clues (such as a or an)?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>7. Have the units been indicated when numerical answers are expressed in units?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>8. Have the items been phrased so as to minimize spelling errors?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>9. Can each statement be clearly judged true or false?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>10. Have specific determiners (e.g., usually, always) been avoided?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>11. Have trivial statements been avoided?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>12. Have negative statement (especially double negatives) been avoided?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>13. Have the items been stated in simple, clear language?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>14. Are the true and false items approximately of equal length?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>15. Is there an approximately equal number of true false items?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>16. Has a detectable pattern of answers (e.g., T,F,T,F) been avoided?</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>17. Is the material in the two list homogeneous?</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>
18. Is the list of responses longer or shorter than the list of premises? Y N
19. Are the responses brief and on the right-hand side? Y N
20. Have the responses been placed in alphabetical or numerical order? Y N
21. Do the directions indicate the basis for matching? Y N
22. Is all of each matching items on the same page? Y N
23. Does each item stem present a meaningful problem? Y N
24. Are the item stems free of irrelevant material? Y N
25. Are the item stems stated in positive terms (if possible)? Y N
26. Are the alternatives grammatically consistent with the item stems? Y N
27. Are the alternatives answers brief and free of unnecessary words? Y N
28. Are the alternatives similar in length and form? Y N
29. Are the items free of verbal clues to the answer? Y N
30. Are verbal alternatives in numerical order? Y N
BIBLIOGRAPHY


Tips for readers of research. (1986, September). *Phi Delta Kappan*, 75-76.


