Order Number 9134146

An assessment of Michigan police officers' cognitive knowledge retention of information presented in MSU's Accident Investigation One training program

Lee, Daniel G., Ph.D.

Michigan State University, 1991

U·M·I
300 N. Zeeb Rd.
Ann Arbor, MI 48106

An Assessment of Michigan Police Officers' Cognitive Knowledge Retention of Information Presented in MSU's Accident Investigation One Training Program

By

Daniel G. Lee

A Thesis
Submitted to MSU
in partial fulfillment of the requirements
for the degree of

Doctor of Philosophy

Department of Educational Administration

1990

ABSTRACT

An Assessment of Michigan Police Officers' Cognitive Knowledge Retention of Information Presented in MSU's Accident Investigation One Training Program

By

Daniel G. Lee

The purpose of this study was to investigate the degree of police officers' cognitive knowledge retention of subject matter presented to them during their attendance of MSU's Accident Investigation One training program. The researcher evaluated the relationship between the retention of cognitive information and selected demographic and job related variables.

One hundred police officers who had previously attended the AI-1 training course were asked to participate in the evaluation. Each officer was asked to retake the post test that was administered at the completion of their respective AI-1 training program. Part of this evaluation compared the mean score of the original performance test with the mean score of the performance retest. The variables used for comparison were: (1) time elapsed since taking the original test, (2) age of the officer, (3) education level and (4)

number of accidents investigated in the 12 months preceding their taking the performance retest.

The first analysis was a paired-samples t-test. Paired samples were used on the original performance test scores and the performance retest scores for the entire sample. This same analysis was used for each of the groups formed using the demographic variables.

For the second evaluation, analysis of covariance was used for each of the four demographic variables (time, age, education and experience) to determine their relationship with the dependent variable (performance retest) and the covariate (original performance test).

Results

1. The 100 subjects, when treated as one group, showed a significant loss of retention when comparing mean scores of the original performance test and the retest.

2. Dividing the sample into various time periods since completing the training showed, that the longer the elapsed time since taking the training, the lower the retest score.

3. Analysis of officer education level and the performance retest mean score, indicates there is not a significant relationship between education level and mean scores.

4. The analysis, based upon officer age and its relationship to the performance retest mean score, showed that a significant relationship did not exist.

5. The number of accidents investigated by officers during the year preceding the performance retest was not significant in terms of its relationship to the performance retest.

ACKNOWLEDGMENTS

The author is grateful to a number of individuals who, during the course of this study, offered and provided assistance which helped to make this endeavor possible.

Special appreciation is extended to Dr. Eldon Nonnamaker, Professor in Administration and Higher Education, whose support, understanding and availability as Chairman of my Guidance Committee was invaluable.

Appreciation is extended to Dr. Louis Hekhuis, Professor in Administration and Higher Education and Dr. Robert Gustafson, Professor in Education and Engineering, as members of my guidance committee, their shared insight, direction and encouragement given during the course of this study were deeply appreciated.

A special thank you is extended to Dr. Betty Giuliani, Professor of LifeLong Education, who as a guidance committee member provided a tremendous amount of assistance in research methodology, statistical analyses and general encouragement.

Special appreciation is also extended to Mrs. Eunice Weber for her excellent typing skills and patience.

Finally, to my wife, Sandy, and my daughter Danielle, I offer my deepest thanks for their encouragement, patience and many sacrifices.

TABLE OF CONTENTS

Chapter

LIST OF TABLES

CHAPTER 1

THE PROBLEM

Introduction

There were 1,704 persons killed and 155,713 persons injured in 410,437 reported motor vehicle traffic accidents in Michigan during 1988 (Michigan Traffic Accident Facts, 1987). Michigan highway deaths have been at this level or higher for several years. Within the United States during 1988 there were over 48,000 people killed as a result of motor vehicle collisions (National Safety Council, 1989).

In the state of Michigan, sworn police officers have a statutory duty to investigate motor vehicle accidents. Every police department is required by state and federal law to report the details of traffic accidents to a central location within their state. The Michigan Department of State Police is assigned the function of compiling accident records for Michigan.

Information from highway traffic accident reports is the basis for many decisions that are made by branches of federal, state and local governments. In addition to governmental units and various levels of courts, the insurance industry and educational institutions base decisions upon information

received from accident reports. When a police officer files a report, prosecutors make decisions about criminal charges that can be made against a driver of a vehicle involved in a serious personal injury or fatal collision. That decision to prosecute (or not) obviously can have a lasting effect on the driver and families involved. Many civil suits directed at individuals, units of government and private and public corporations are based upon the report submitted by the investigating police officer. The cost of civil suits is high. Government units, insurance companies, individuals and corporations in Michigan spend millions of dollars every year defending themselves in civil suits and/or paying judgements awarded by courts and arbitration panels.

Federal, state and county highway officials and engineers use the compiled data from police reports to base their decisions on highways they design, maintain and repair. Decisions on speed limits, placement of signs or signals and parking are only a few of the decisions that are often based upon accident investigations made by police officers.

Many universities, including Michigan State University, conduct research on specific aspects of highway transportation and safety. Grant dollars from state, federal, corporate and private agencies are being used to perform evaluations which are used to make recommendations about transportation. Faculty at Michigan State University and University of Michigan are currently using accident reports prepared by

police officers as the primary or sole source of data for state funded research projects.

The National Highway Traffic Safety Administration (NHTSA), the Insurance Institute for Highway Safety and other private and public groups use police reports as a basis for recommendations for legislation and the development of federal standards that control certain aspects of vehicle design. Classification of collisions and type of injuries received by vehicle occupants originate with investigating police officers, and are later interpreted by the above groups to determine vehicle safety features. This can obviously have an effect on vehicle manufacture in terms of the cost to produce vehicles that meet federal safety standards.

The citizens of Michigan who own and operate motor vehicles are subject to the state's no-fault insurance law. Whether the motoring public agrees with the insurance law or not, in part the passage of that law was based upon accident statistics compiled in police traffic accident reports. Most Michigan drivers are also aware of the insurance premium required by their individual insurance company. Insurance premiums are in part based upon accident records which provide the information about the type of collision and resulting injuries.

Despite the large number of motor vehicle collisions and the impact the results of the investigation can have on individuals and the transportation system in general, only limited mandatory training is provided in the specific

knowledge and skills the police officer needs to properly investigate a traffic accident.

Required Basic Police Training in Michigan

Public Act 203 of 1965 was the legislation that required statewide control of employment and training standards of police officers in Michigan. Since that time, most of the training and education police officers received was governed by the Michigan Law Enforcement Officers Training Council (MLEOTC). This council consists of three Sheriff's, three Chief of Police appointees, one member from the Detroit Police Officers' Association, one member from Metropolitan Club, the Attorney General and the Director of State Police.

MLEOTC determines the requirements for mandatory basic police training and advanced in-service police training programs. In Michigan once an applicant meets all requirements to enter a police academy, he/she must complete 440 hours of mandatory training. Only 18 hours consists of instruction on how to complete the State's accident report form; very little instruction is provided on how to actually investigate a traffic accident.

The second area MLEOTC focuses upon is categories or classification of advanced in-service training programs. MLEOTC approval must be obtained by individuals or organizations prior to their presenting in-service programs.

Background of the Problem

There are numerous in-service training programs that address the various needs of police work. Individuals, agencies, colleges or universities who wish to present in-service training to police officers must have MLEOTC approval. MLEOTC establishes training standards, authorizes training and is also responsible for conducting on-going evaluation of training programs to assure a sustained level of quality.

MSU provides MLEOTC certified training to police officers. One subject matter frequently presented by MSU over the past decade is traffic accident investigation. Other subjects include radar, police alcohol enforcement, traffic engineering, supervision, management, pursuit driving and other related police topics.

When a police officer in Michigan completes academy training or an in-service training program, the officer's mastery of the subject is based upon or demonstrated by successful completion of a written post-test. There is very little research to date that addresses the need for continued assessment of the police officer. Emphasis has been in pre- and post-test results with little attention given to the degree of retention of knowledge and skills needed to do specific tasks accurately and safely.

Michigan State University has addressed the need for additional and improved police officers' accident investigation knowledge by presenting training programs that deal with accident investigation. A five day (35 hour) training program

entitled Accident Investigation One (AI-1), developed by Michigan State University, Civil and Environmental Engineering and the Highway Traffic Safety Programs has been certified by MLEOTC. The AI-1 training program has become the "standard" for Michigan police officers to successfully complete once they have been employed by a police agency and have accident investigation duties.

To date, MSU has also relied on use of a post-test to measure the officer's mastery of AI-1 training materials. No attempt has been made to evaluate the cognitive knowledge retention of police officers who have received MSU and MLEOTC certification after having completed the AI-1 training course. Currently, there are no requirements stating that police officers must receive refresher training or be tested in later years to determine if they have maintained their AI-1 knowledge.

Problem Statement

Police officers are required to investigate and make reports on motor vehicle accidents. The content of accident reports can have a profound effect on many people, either directly or indirectly. The problem is that, up until now, no attempt has been made to measure the retention of AI-1 cognitive knowledge once the officer has been back in the field and performing the assigned duty of investigating automobile accidents.

Purpose of the Study

The researcher's purpose in this study was to investigate the degree to which cognitive knowledge gained in the AI-1 training course may be retained over varying periods of time while police officers are performing their assigned duties in the field.

Need for the Study

The Michigan Office of Highway Safety Programs (MOHSP), National Highway Traffic Safety Administration (NHTSA), Michigan State University, Civil and Environmental Engineering (MSU CEE) and the MLEOTC indicated interest in a need for the assessment of the retention of knowledge and skills mastered in AI training programs. The interest and need for this type of study has been indicated from the above organizations by the following.

1. The Michigan Office of Highway Safety Planning (MOHSP) which has funded MSU Highway Traffic Safety Programs to develop and present accident investigation training has advised MSU that funding for this type of training will end, if "long term" benefit to the police officers and the state in general cannot be demonstrated.

2. The Michigan Law Enforcement Officers Training Council (MLEOTC) which is responsible for certifying the accident investigation training, needs documentation to help it decide if annual refresher AI training should be mandatory.

3. The National Highway Traffic Safety Administration (NHTSA) is currently proposing national standards for police traffic accident investigation. The proposed standards will address:

a. accident investigation training program content;

b. hours of accident investigation training needed before an officer will be recognized as a competent investigator;

c. standardized national testing; and,

d. recertification based upon additional training and/or testing, in the frequency of recertification as a primary issue.

4. The Michigan State University Civil and Environmental Engineering, Highway Traffic Safety Programs (MSU CEE HTSP) which is currently developing additional accident investigation training programs, while continuing to present the Accident Investigation 1 (AI-1) training program, needs to know how much cognitive knowledge from previous AI training has been retained. Administrators from Michigan police departments frequently request refresher classes and/or updated AI training be provided by Michigan State University. A decision must be made to determine the need, content and frequency for this type of follow-up training.

5. This study could be shared with other training and/or enforcement organizations which have accident investigation training responsibilities.

Research Questions

This study was directed at answering the following research questions. Hypotheses based upon these questions follow.

1. Is there any variation between the mean score of the original performance tests administered to the test group at completion of their respective AI-1 course and the performance retest mean score of the test group as a whole.

2. After varying intervals of time have elapsed since completing the Accident Investigation 1 (AI-1) program, what degree of retention will officers in one interval of time have as compared to officers in other intervals of time?

3. What relationships, if any, exist between level of education and the written performance retest scores?

4. What relationships, if any, exist between the performance retest scores and the number of vehicle accidents an officer investigated within the one year period prior to taking the performance retest?

Research Hypotheses

The following hypotheses were tested in this study:

Hypothesis 1: The total sample of officers when treated as one group will not show significant loss of retention as measured by the original performance test scores compared with the performance retest.

Hypothesis 2: When dividing the total sample of officers into groups based upon varying intervals of time, officers' retention levels will not vary significantly between the groups as reflected by the mean scores on the performance retest.

Hypothesis 3: Officers' education level will not show a significant relationship with performance retest scores.

Hypothesis 4: Officers' age will not show a significant relationship with performance retest scores.

Hypothesis 5: The number of vehicle traffic crashes investigated by officers during the one year period prior to their taking the performance retest will not show a significant relationship with performance retest scores.

Definition of Terms

Accident: An unplanned event causing contact between two vehicles or objects resulting in damage and/or injury.

AI-1: The Police Traffic Accident Investigation 1 Training Program developed and presented by MSU HTSP. The course is a 35-hour program that provides instruction to in-service officers on how to conduct a comprehensive on-scene investigation of a traffic accident.

Correlation: A numerical index of the degree of relationship between two variables on the same population.

Elapsed Time: The amount of time between the completion of AI-1 and taking the performance retest.

Investigation: A systematic examination and gathering of all facts and related information connected with a situation commonly called a highway vehicle collision.

Original Performance Test: The AI-1 post test that was administered to the police subjects in this study when they originally took AI-1. This is a written (paper and pencil)

test consisting of multiple choice, true/false, calculation problems and picture identification.

Performance Re-Test: Same as performance test. AI-1 post-test required to be administered at completion of a MLEOTC-certified training program.

Retention: The ability to recall cognitive information to correctly answer test questions.

Organization of Study

This research is presented in five chapters. Chapter 2 contains a review of the literature. Included is a review of current literature related to research concerning various aspects of cognitive retention. The third chapter contains a description of research methods used in this study along with validity and reliability concerns and a summary. Chapter 4 is a review of the implementation of this study and contains the research findings. The summary, conclusion, and recommendations are presented in Chapter 5.

CHAPTER 2

REVIEW OF LITERATURE

Retention has been of great interest to psychologists, educators, researchers of human development and others concerned with the learning process in adults. Investigations of time-related retention under various conditions have been reported in the literature. Since this study was primarily concerned with evaluating the degree to which cognitive knowledge is retained over time, two types of retention studies were reviewed. First were studies of the nature of retention and the process by which retention is formed. Second were studies of the relationship of retention to such factors as using pre- and post-test to measure the retention.

The major purpose of this study was to investigate the retention of cognitive knowledge as it applies to adults, namely police officers. The studies cited in this review are related to longitudinal retention of cognitive knowledge.

Historical Perspective of Retention Studies

Philosophers have analyzed the processes of the mind in great detail. This interest began in ancient Greece. Between the period of 1650 and 1850 the school of British Philosophy wrote mostly about empiricism. Its contributions were from

great philosophers such as John Locke, George Berkeley, David Hume and James Mill. Even though most of their philosophies differed, they all agreed upon the basic doctrine of empiricism, which states that all knowledge comes from experience or that the contents of the mind are learned. The European rationalist philosophers such as Rene Descartes and Immanuel Kant believed that peoples' ideas are innate and that knowledge comes with heredity rather than experience. According to the rationalists, people experience events in terms of space, time, and causality because this is the way the mind imposes structure on one's experiences of the world and not necessarily the way the world is.

Up to the 1930s, philosophers believed that people forgot (did not retain information) because of the Law of Disuse. The notion was that the memory trace that was not exercised faded away. We still hear "use it or lose it" when talking about knowledge and/or skills. Thorndike (1914) stated that "When a modifiable connection is not made between a situation and a response during a length of time, that connections's strength is decreased." McGeoch (1932) attacked the theory of Law of Disuse from several points of view. He said, "Time of itself does nothing about the cause of forgetting." The only role time plays is to provide the cause of forgetting to operate. He said that, to find the causes of forgetting, one has to look at what happens during the retention interval. He stated "Extinction occurs when a habit is being exercised and spontaneous recovery when it is not." This is the opposite of

what the Law of Disuse predicts. Retroactive interference could result from everyday activity and during the retention interval could play a part in lack of retention.

Retention Defined

According to the Thesaurus of Psychology: Index Terms, (1988), "Retention is the persistence of a learned act, information or experience as measured by reproduction, recall, recognition or relearning. It is applied to long term or short term memory." (p. 291)

Retention Measurements

Ebel (1972) stated that educators used tests to measure students' achievement and evaluate their educational progress within the classroom. Law and Bronson (1977) stated that "Criterion referenced tests have gained in popularity until today they provide an alternative to the more traditional norm-referenced test." Glazer and Cox (1981) carried on the investigation to discover that "measuring of training success can be classified as either norm-referenced or criterion-referenced." This theory coincided with Law and Bronson's. Norm-referenced means that test scores are compared to scores made by some defined reference group. They are compared on a relative scale of measurement. Criterion-referenced assessments are made by assessing the effects of the training on observable job-related behavior. Little research in this critical area exists.

Effects of Retention Interval

Ebbinghaus (1885), who specifically investigated the effects of retention intervals, discussed properties of retention and characterized the rate of forgetting through intervals which he called "classic retention function." He introduced a method whereby memory could be measured objectively during a situation where the time and degree or original learning could be carefully specified. Observations were quantitative as well as objective. Ebbinghaus was obsessed with the ideas of precise measurements by control of factors such as mental attitude and the time of day that learning took place. His publication in 1885 opened a new era to scientific investigation.

The primary thrust of Ebbinghaus's contribution was the theory of retention of associations over a period of time. He agreed with the British empiricism theory. To Ebbinghaus subjectively, retention depended upon two factors: the initial depth of impression on memory and the amount of time it took for the impression to fade. He sought objective, quantitative measurements that could be used to measure depth of impression and time that the impression faded. He replaced depth of impression with counting the number of times the list (of nonsense syllables) was repeated in the original learning. To determine the extent the impression faded (had been forgotten), he proposed that the list be relearned after an interval of retention was given. Forgetting could be measured by comparing the number of trials (time interval) needed to

relearn the list of words with the number of trials (time) needed to learn the list in the first place. He called this comparison "savings" score and established a percentage.

EXAMPLE OF FORMULA USED BY EBBINGHAUS

$$\text{Percentage savings} = 100 \times \frac{\text{Trials to learn} - \text{trials to relearn}}{\text{Trials to learn}}$$

If it took 40 trials to learn the initial list, according to the formula, it would take 40 trials to relearn, "savings" equal 0 percent, no effort is saved as a result of previous practice on the list. So there is no evidence of retention at the time of relearning. If relearning requires no effort (practice) and can be recited perfectly at the first attempt, "savings" equal 100 percent. If relearning takes 20 trials, "savings" equal 50 percent, and so on. The savings score provides a very sensitive measure of retention. Ebbinghaus's retention was about 32 percent of the learned list which showed that the retention of learning in a 24-hour period was considerable. Repetition beyond the point of learned material he called "overlearning".

Curve of Retention

Ebbinghaus (1885) is also credited with the idea of the curve of retention. "The curve of retention is a graphic representation of what remains in the memory, displaying the frequency of correct reproduction of learned information over a period of time or a number of trials" (International Dictionary of Education). Through the use of the curve of

retention, Ebbinghaus concluded that "if the quantity of matter to be learned is increased slightly, the time taken to learn it increases considerably."

Ebbinghaus experimented in trying to plot the function of retention as it related to time. He memorized lists of nonsense words with three letters such as bok, jiw, by taking two consonants and placing a vowel between them so as not to make a German word or sense. He learned a list of these words and later relearned another list of 1,228 words and made the nonsense words by adding 13 syllables each. His retention dropped off rapidly at first. After 19 minutes he had retained about 59 percent and retained about 45 percent after one hour. He found that the rate of forgetting was much slower over longer periods of time. He retained about 28 percent of the information after two days while retaining 21 percent after 31 days. The change in the rate of forgetting over time intervals at first showed rapid decline and later became slower at longer time frames. This he called "classic retention function". He explored the idea of making a mathematical model to fit his retention curve. Retention reached zero as the time interval reached infinity. He believed that his retention became lessened in the memory with time.

Retention Affected by Degree of Learning

According to Ebbinghaus's theory, there is a straight line relationship between the number of original learning

trials and the number of trials saved in relearning. The more trials of original practice, the less effort is necessary for relearning. For example: if one spoke German as a child and did not use this learning as an adult, one's memory of German would come back with a little practice in German to the degree that one knew it before.

Ebbinghaus's theories were highly criticized as to methods he used but he made a great contribution at a time when higher mental processes were the obsession of philosophical psychology, when observations were all subjective and conditions of observation were uncontrolled. He introduced a method of measuring memory objectively where a given situation, time and degree of original learning, could be carefully specified. He also pioneered the retention research.

Kirkpatrick (1894) discovered that false recognition of words semantically related to those in the list based on word meaning of other words could cause the person to match the wrong words to each other. Kirkpatrick refined Ebbinghaus's theory. However, Kirkpatrick's theory received little attention until Atkinson and Shiffrin (1971) made observations using a two-process theory. The sensory register (auditory or visual) registers stimuli information into the short-term store (STS) of memory. Data decay rapidly from visual sensory information in about 1/2 second. In auditory information the data last about 3 seconds. The short-term store is the working memory. It is stored and copied into permanent memory which is called long-term store (LTS). Short-term store may

not last long enough for retention. Rehearsal strengthens STS and prolongs the data in memory. LTS is like a storage place. Memory can be retrieved and is guided by control processes. Data come to the memory involuntarily and can be retrieved without conscious effort. (Example: a person who has learned 6x4=24 recalls without effort, if the problem is stored in memory.) This retention is related directly to LTS and by-passes STS according to the authors.

Ausubel (1968) tested the hypothesis that the "learning and retention of unfamiliar but meaningful material can be facilitated by advanced introduction of concepts." The basis of his theory was that cognitive structure was organized in a hierarchy of concepts and subconcepts. In order to facilitate the process of acquisition and retention of meaningful material, Ausubel advocated the use of advanced organizers.

> The most efficient way of facilitating retention is to introduce appropriate subsumers and make them part of the learning task. The introduced subsumers thus become advance organizers' or anchoring foci for the reception of new material. In effect, they provide an introductory overview at the appropriate level of conceptualization. (pp. 8-9)

He identified three important attributes which support the need to incorporate them into the learning materials: (1) Advanced organizers that are specifically constructed for specific learning materials are an efficient method used to facilitate the retention of subject matter, (2) Organizers are better used with factual materials than for abstract (concepts, principals or generalizations) materials, (3) In

advance learning materials, organizers would facilitate integration and thereby retention would be more effective.

Blanton (1972) clarified Ausubel's theory of Reception Learning by stating "In theory of meaningful verbal learning, a major concept is that new material which is to be learned must be related to the learner's existing cognitive structure."

Tulving and Watkin (1973) gave an interesting twist to Ebbinghaus's theory. They had a list of five-letter words and gave the subject two, three, four and five letters of the word as cues and asked the subject to write the word from the list they were to retain using the cues. (Examples: the word might be Pepsi. They could be given Pe, Pep, Peps, Pepsi, they were to recall the word Pepsi.) The authors believed that retrieval cues might be necessary for memory retrieval and, if not necessary, would at least be very helpful. Critics have stated that the data from memory depend on the memory cue and also on the surrounding context in which the cue is given. They have cited where guessing by using the cue would have a 50 percent correct response.

Anderson and Biddle (1975) found a strong relationship between increased application (practice) of materials and subsequent retention. LaPorte and Voss (1975) seemed to concur with Anderson and Biddle in their studies. They demonstrated that superior retention was the result of usage of the information and performance feedback.

Singer (1975) stated that retention can be determined by "measuring the difference between the amount originally learned and the amount forgotten". Acquisition of subject matter to become functionally competent, lends complexity to the students' ability to retain information by the referring of concepts and content transfer to practical application of knowledge. Davey (1976) concluded that a student's cognitive style defined as stable preferences in individuals with respect to conceptual categorization and perceptual organization of the external environment was a critical factor in maximizing retention and performance.

Sage (1977) stated that retention is the savings of proficiency after a period of non-practice. Mehrens (1986) concurred with Sage in his studies that "criterion referenced tests have gained in popularity until today they provide an alternative to the more traditional norm-referenced tests". Glazer and Cox (1981) concurred with Mehrens by reporting that "Measures of training success can be classified as either norm-referenced or criterion-referenced." (pp. 352-359) Norm-referenced means that test scores are compared to scores made by some defined reference group. They are compared on a relative scale of measurement. Criterion referenced assessments are made by assessing the effects of the training on observable job-related behavior. Little research on this critical area exists.

Gagne (1978) predicted that students' exposure to different types of learning environments would affect

performance on tests of academic ability. This study examined performance in two different learning environments in order to detect changes in retention of academic performance resulting from participation in one of the two environments during the learning-interval. He stated that the traditional classroom is not the only or the best learning environment; meaning that the outdoors, home or job could be a learning environment.

Longitudinal Retention

The ultimate results in longitudinal retention were defined by Cornwell (1980) as "on-the-job performance of trainees after training." He noted that "one of the weaknesses of learning evaluations designs is the failure to do longitudinal studies... and that the post-training application of skills is difficult to measure without access to employees back on the job" (p. 99). Swierczek and Carmichael (1985) concurred with this theory.

Retention Affected by the Strategies Used

The effectiveness of the strategies used to learn tasks has been found to have a significant relationship to retention. Waters (1982) studied the relationship between strategy use and memory performance and found that there were no differences in recall as a function of strategy. This finding may have resulted from the fact that most students adopt strategies that are relative to the task that they are to perform and that the study was limited to students who used

poor strategies or no strategies at all which would lead to varying degrees of performance.

McLeod (1983) considered that there were two modes of learning: (1) One achieved by gradually mastering complex cognitive skills by concentrating on sub-tasks to be mastered, such as the correct phonetic sound for pronouncing a word. This frees the learner to begin on another sub-task, namely, the use of the word in a sentence or syntax. The learner often loses contact as to learning how these parts fit into a whole sentence, paragraph and story. (2) The other mode of learning was restructuring. It is the process of grouping information into related units, rather than isolated bits.

Carrol (1985) stated that there was a relationship between time and learning and he broke time into three categories: (1) engaged time, (2) time on a task, and (3) allocated time. He concluded that the extent of time spent in learning (allocated and/or engaged time) will maximize the learning. Carrol cautioned that time spent in learning was crucial but not always sufficient for achievement. He also stated that the amount of time spent on a task was the smallest of three factors: (1) learner's perseverance (amount of time student was willing to give actively in learning), (2) time allocated for learning, and (3) time needed for learning.

Pressley (1985) concurred with the other studies on strategies and retention; however, he seemed to take the theory one step further. He suggested that strategic knowledge involved more than simple awareness that a particular

strategy was useful in cognitive learning. He believed that knowledge about the conditions for strategy use, the effort required and the usefulness of the strategy in previous situations may all contribute to the decision to adopt a particular strategy. Such strategy knowledge would be expected to affect the strategic behavior adopted and in turn to be affected by experience in task situations.

Cheng (1985) proposed that improvement in performance can be due to a restructuring of the components of a task so that they are coordinated, integrated or reorganized into new units, thereby allowing the procedure involving the old components to be replaced by a more efficient procedure involving new components. She gave an example of playing two hands on a piano. Cheng indicated that the difficulty does not stem from any physiological limitation, but rather from the lack of s suitably structured skill.

Justice (1986) concluded that recall was better when the text was structured and strategies such as a standard order of presentation were used; for example: introduction setting, motivation of the protagonist and ending statement for a story rather than the giving of unrelated verbal materials. Mixed order of presentation resulted in the lowest recall proficiency.

The Effect of Age on Retention

McGeoch (1932) attacked the law of disuse theory with the explanation that the main reason for forgetting was because of

retroactive interference; this was accepted for 25 years. Underwood (1960) refuted McGeoch's theory, stating that the same subjects had been used over and over in different conditions, which tainted the studies. McGeoch's hypothesis of retroactive interference was questioned. Underwood argued that the major cause of forgetting in most of his experiments was not retroactive interference but proactive interference which caused differences in recall. Underwood discovered that retention was closely related to the number of lists a subject had learned previously in the same experience. When the list being tested was the first, retention was about 75 percent accurate. When there were 20 or more previous lists, retention was below 20 percent. The relationship between previous lists and retention was almost identical to Ebbinghaus's curve.

Postman (1961) claimed: "Interference theory occupies an unchallenged position as the major significant analysis of the process of forgetting." Gladis and Braun (1958) found that when scores were corrected for differences in original learning, there were no age differences in retention. Mehrens (1986) concurred with this finding.

Scovel (1982) designed an experiment to investigate the second language learning process in the setting in which language learning is most likely to occur in the United States of America. Flavell (1982) did a similar experiment which entailed the initial stages of language learning. He assumed that since the experiment entailed the initial stages of

language learning, there would be considerably more "consistency and homogeneity" in the subjects' responses relative to their age groups than in their "subsequent cognitive management" of this learning event. Results revealed little difference among age-related learning in terms of overall test-score results.

Summary

Ebbinghaus's (1913) findings seemed to indicate that there is a positive relationship between the time that data are given and the retention of these data. However, in his studies he did not consider the content of data or procedures for the data to be given which seems important in trying to prove the extent of such relationship (time intervals and retention of data).

Ebbinghaus's study showed evidence of a positive relationship of properties of retention and the rate of forgetting. Kirkpatrick's and Atkinson's investigations revealed similar trends about this relationship. Retention seems to appear in stages or in time frames and is manifested by (1) the time that data were presented, (2) the learning of the data (3) the amount of time needed to recall the data, and (4) how much of the data were retained.

In summary, the following conclusions seem to be supported by evidence from previous studies:

1. From grade level to grade level there seems to be an increased ability for retention.

2. Adults retain data, if they are useful to their needs (job).

3. Attempts have been made to determine the relationship of memory and retention but no firm conclusions have been reached.

4. During a retention interval, when forgetting is correlated with time, there is sometimes retroactive interference.

5. Some research has suggested that the causes of forgetting over short- and long-retention intervals are not different, while other research shows that forgetting is greater immediately after learning and the forgetting process slows as time increases.

6. Most of the forgetting studied in memory experiments can be classified as either proactive or retroactive interference.

7. By restructuring components of tasks so that they are organized, integrated and reorganized, performance and retention are increased.

8. There are no age differences in retention when scores are corrected for differences in original learning.

This review of the literature led the researcher to conclude that little, if any, specific research has been done to determine whether police officers retain cognitive information over varying periods of time. However, studies have dealt with longitudinal assessment of knowledge retention. It seems that the latter authors/researchers have based their

theories upon Ebbinghaus's ideas and have expanded the idea to conclude the restructuring of learning into related units rather than isolated bits, as has been promoted by learning theorists up to the present time.

Discussion of Previous Research

This research investigated the possible relationship that time, age, educational level and/or the number of accidents investigated may have to the police officers longitudinal retention of cognitive knowledge gained in the AI-1 training program. The testable hypotheses stated in chapter 3 are based upon information the researcher gained from the review of the literature. Hypotheses can be stated in the null form, which does not necessarily reflect the researcher's expectations. The null form states that no relationship exists between the variables.

In cases where the researcher has strong reasons to expect a significant difference to occur in a specific direction, hypotheses can be written to reflect direction. Borg and Gall (1974) stated that "hypotheses that state (sic) a specific expected direction for the finding, should only be used when there is little or no possibility that the findings will yield a difference in the opposite direction."

Information provided by Ebbinghaus, Kirkpatrick, Anderson and Biddle indicated that retention can be affected by time and use of the cognitive knowledge. A search and review of the literature did not provide adequate information to enable

this researcher to make predictions about the relationship that the variables of age and educational level may have to retention.

CHAPTER 3

RESEARCH METHODOLOGY

The Sample

The researcher's purpose in this study was to determine the degree to which cognitive knowledge mastered by police officers who attended the Accident Investigation 1 (AI-1) training program has been retained over varying periods of time. The police officers who participated in this longitudinal study were:

1. AI-1 trained officers from the Eaton County Sheriff's Department;
2. AI-1 trained officers from the Ingham County Sheriff's Department;
3. AI-1 trained officers who attended three MSU advanced level AI training programs during September of 1989.

The participating officers were divided into three separate groups based upon the total elapsed time since completion of AI-1. The time divisions were, (1) more than 4 months through 12 months, (2) more than 12 months through 36 months, and (3) more than 36 months. In this study the focus

was on the retention of cognitive knowledge over varying periods of time, as measured by scores on written tests.

Testable Hypotheses

The hypotheses for this study are stated in the null form. The null hypothesis states that there is no relationship among the variables identified for this research, which are mean scores for the original performance test, mean scores of the performance retest, time, age, educational level and the number of traffic accidents investigated during the 12 months prior to taking the performance retest. The statistical tools selected to test the hypotheses and the levels of confidence are identified in other sections of this chapter. Two research hypotheses were tested to examine AI-1 cognitive knowledge retention over time. Three additional hypotheses were tested to determine whether age, education level and the number of traffic accidents investigated were related to retention over time.

The first evaluation was to determine whether there was a significant difference between the computed mean score of the original performance test taken by the police officers included in this study at completion of their respective AI-1 program as compared to the mean score of the performance retest taken by the same group of police officers.

Hypothesis 1: The total sample of officers when treated as one group will show significant loss of retention as calculated by the performance retest.

The second evaluation was to determine whether there was a significant difference in mean scores based upon the amount of elapsed time since completion of AI-1 training. The mean scores of the performance retest were used to compare the three groups, which were divided by time segments as follows:

Group 1 = more than 4 months to 12 months

Group 2 = more than 12 months to 36 months

Group 3 = more than 36 months

Hypothesis 2: When dividing the total sample of officers into three groups based upon interval of time since completing the AI-1 program, officers' retention levels will vary significantly as reflected by the group mean scores on the performance retest.

The third evaluation was to determine whether a relationship existed between education level and retention over time. The three subgroups for education were defined as follows.

Group 1 = High School Diploma but less than an Associate Degree

Group 2 = 2-year Associate Degree but less than a 4-year degree

Group 3 = 4-year degree or more

Hypothesis 3: Officers' education level will not show a significant relationship with performance retest scores.

The fourth evaluation was to determine whether a relationship existed between age and retention over time. The four subgroups for education level were defined as follows:

Group 1 = 24 to 34 years of age

Group 2 = More than 34 to 37 years of age

Group 3 = More than 37 to 42 years of age

Group 4 = More than 42 years of age

Hypothesis 4: Officers' age will not show a significant relationship with performance retest scores.

The fifth evaluation was to determine whether there was a relationship between the number of traffic accidents officers investigated and mean scores on the performance retest. The sample was divided into five subgroups based on the number of personal injury and/or fatal accident investigations conducted during the 12-month period before they took the performance retest. The five subgroups were defined as follows.

Group 1 = No accidents investigated

Group 2 = 1-10 accidents investigated

Group 3 = 11-35 accidents investigated

Group 4 = 36-65 accidents investigated

Group 5 = 66 or more accidents investigated

Hypothesis 5: The number of personal injury and/or fatal vehicle traffic crashes investigated by officers during the one year period prior to taking the performance retest will show a significant positive relationship with the mean scores on the performance retest.

AI-1 Original Performance Requirements

To complete the AI-1 training course successfully, MLEOTC required the officer to achieve a score of 70 percent or above on the original performance test. The performance test has a total of 62 questions, which equals a total of 100 points.

Population Selection

The most practical procedure to obtain a sample of Michigan police officers was to administer the performance retest at the beginning of other training programs that MSU HTSP presents at central training facilities. During September 1989, MSU scheduled three advanced Accident Investigation Training programs. One requirement of attending the advanced program was that officers have successfully completed the AI-1 training. One advanced program was conducted at each of the following three sites: Macomb County Criminal Justice Training Center, Detroit Metropolitan Police Academy in Wayne County and the Southfield Police Department in Oakland County. Over the past several years a large percentage of the officers who attended AI-1 received their training at these same three locations.

Additional officers included in the study were the AI-1 trained officers from the Ingham and Eaton County Sheriffs' Departments. The officers from these two departments received their AI-1 training through Lansing Community College Justice and Law Center. Approximately 80 percent of the police officers in Michigan who have attended AI-1 received their training at one of these four training facilities.

Performance Retest Procedure

Officers attending the three advanced training programs in Wayne, Macomb and Oakland Counties were asked at the start of the class session if they would be willing to take the

performance retest. All officers in the class were willing to be involved in the retest.

The officers from the Ingham and Eaton County Sheriffs' Departments were assigned to a classroom within their police facility. The performance retest was scheduled at the beginning of duty. Test subjects did not receive advanced notice of the retest. This procedure reduced the possibility of the individual officers preparing for the performance retest.

In police departments, it is not uncommon for administration to order personnel to do certain things. In this performance retest situation, only those who were willing to participate were given the test. Several testing sessions at each sheriff's department were necessary to obtain the maximum number of AI-1 graduates from each department.

Test Instrument

The measurements taken were test scores from a validated test (Nerbonne, 1980), which was also certified by the MLEOTC (see Appendix D & E). The written paper and pencil performance retest instrument was the same one used at completion of the AI-1 training program that each subject attended. Scoring of the performance retest was completed in the same fashion as the post-test administered at completion of each AI-1 course. The same scoring key and assessment were used. The test was designed to measure the degree of AI-1 content cognitive knowledge.

Validity Concerns

The same two primary instructors have taught all the AI-1 courses that the participants in this study completed. Training course material outlines were revised and/or updated but the basic content has remained the same. This set procedure of presentation and material content reduced the possible variations that could arise if many instructors using various materials were employed.

The total number of subjects in the study was 100. Based upon the number of subjects, cell sizes for some of the individual groups were small. Small cell size can be considered a threat to validity (Borg & Gall, 1971). In this research, if any individual cell size created a validity concern, a comparison of that cell was not made. A minimum number of five was the smallest acceptable/testable cell size for this study.

The use of identical original performance tests and performance retests was not a threat to internal validity for the following reasons:

1. The time period that elapsed between the testing periods was between four months and 120 months.

2. At completion of the AI-1 post-test, the students received their scores but were not provided with copies of the test instrument or the correct answers.

3. The test instrument was the same; therefore, the test content could not be more difficult or easier as a result of test change.

In longitudinal surveys of this nature, maturation can be a variable that affects internal validity. In this situation biological or psychological processes could have an effect on remembering over a period of time. Other events over extended periods of time may also affect retention. This research included the types of variables associated with maturation; they were considered only in the age, education level and experience comparisons which are addressed in Hypotheses 3, 4 and 5.

Reliability Concerns

Some factors can adversely affect the meaning and reliability of change scores, especially those used as a measure of pre-and post-test results. This researcher did not deal with change scores in the pre-test, post-test fashion. The mean scores of the original performance test were analyzed against the mean scores of the performance retest, and the retest means were also compared to the mean scores of the groups based upon time, education and experience. Generally, change scores will be more reliable when experimental data are not being analyzed. The reliability of the test used in this type of study was defined as the consistency of the test in making estimates of the student's level of mastery of the test's domain (Borg & Gall, 1981).

The performance retest instrument was identical to the original performance test given to each subject. It is a valid test and it does assess retention. The AI-1 curriculum

and original performance test were developed in accordance with MSU's Learning System Design professors Davis, Alexander and Yelon. The AI-1 performance test was validated by Nerbonne (1980) in a dissertation entitled "An Evaluation of the Time Formats Used in Teaching the MSU HTSP Introductory Traffic Accident Investigation Course." (See Appendix A for validation summary of Nerbonne.)

Analysis Procedure--Treatment of Data

The Statistical Package for the Social Sciences (SPSS) was used to analyze the data. In the first analysis, descriptive statistics (group mean and standard deviation) were computed for each comparison group in the study.

T-Test (Paired Samples)

This study, like many educational research projects, dealt with small numbers of subjects. In this situation, the t-test is an appropriate statistical tool to determine whether the means differ significantly from one another. The t distribution takes into account the nonnormal distribution of standard errors when the sample size is small (Borg & Gall, 1971). Because the performance retest scores in this research could be greater or less than the original performance scores, the differences in retention had to be examined through the use of the two tailed t-test of significance. Paired samples were used on the original performance test score and the performance retest scores for the entire sample. The same

analysis was used for each of the groups formed using demographic variables. The .05 level of significance was used.

Analysis of Covariance

Analysis of covariance provides a post-hoc method of matching groups on variables such as age, education and experience. It is also designed to determine whether a difference between two groups on a particular variable can be explained by another difference that exists between the two groups (Borg & Gall, 1971). For this study, the performance retest was the dependent variable, and the original performance test was the covariate. Analysis of covariance makes selected groups equal with respect to one or more control variables.

Analysis of covariance was used for each of the four demographic variables (time, age, education level and experience) to determine their relationship with the dependent variable (performance retest) and the covariate (original performance test). An additional analysis of covariance measured the effect that the demographic variables (age, education level and experience) had on the variable of time. For acceptance or rejection of the hypotheses a .05 level of significance was used.

Summary

The researcher's purpose in this study was to investigate the relationship between the retention of cognitive information, originally learned in the AI-1 training program, and

selected demographic and job-related variables, including age, education level and accident investigation experience. Retention was measured by comparing group mean scores on the original AI-1 performance test with group mean scores on the same test taken in mid-1989 (the performance retest).

In this chapter the research hypotheses were presented and the basis of study population selection was explained. Data-collection procedures were explained, and the methods that were used to conduct the analysis were described.

CHAPTER 4

ANALYSIS OF DATA

The Findings

This study was designed to investigate the degree to which cognitive knowledge gained in the Accident Investigation 1 (AI-1) training course was retained over varying periods of time while the police officer continued to perform his/her assigned duties. The methods and procedures for the investigation were presented in the preceding chapter. In this chapter are the findings resulting from the statistical analysis of the data. Data analyses in this chapter include the difference in retention as measured by comparisons of original performance test means and performance retest means against correlations of time, age, education level, and number of traffic accidents investigated in the 12 months preceding the performance retest.

The sections of this chapter are presented under the following headings: Introduction to the Data, Performance Test Mean Scores by Variable Subcategories, Differences between Mean Original Performance Test and Performance Retest, The Effect of Time on the Performance Retest Mean Score, The Effect of Education on the Performance Retest Mean Score, The

Effect of Test Subject's Age on the Performance Retest Mean Score, The Effect of the Number of Accidents Investigated on the Performance Retest Mean Score, Review of the Results of the Analysis of Hypotheses 1-5, The Combined Effect of Time and Education on the Performance Retest Mean Score, The Combined Effect of Time and Number of Accidents Investigated on the Performance Retest Mean Score, and The Combined Effect of Time and Age on the Performance Retest Mean Score.

Introduction to the Data

The total number of subjects in the final statistical analysis was 100: 23 from the Eaton County Sheriff Department, 17 from the Ingham County Sheriff Department, and 60 from the advanced level training programs conducted in Wayne, Macomb, and Oakland Counties. In Eaton County, out of the total number of deputies who previously took AI-1, only two deputies did not take the performance retest; one deputy was on sick leave and one was on vacation. One qualified deputy from Ingham County did not participate in the survey; his current assignment to the regional drug unit precluded his participation. All officers attending the advanced training programs volunteered to participate in this research.

A total of 112 officers completed the questionnaire and took the performance retest. Twelve of the participants had to be eliminated from the total number for the following reasons.

1. Two officers' records were not listed in the computer where all AI-1 records were kept; therefore, neither the dates that they took AI-1 nor their original performance scores could be located.

2. Three officers had attended similar programs through the Northwestern University Traffic Institute at Evanston, Illinois, but did not attend MSU's AI-1 program. (They had to be eliminated from the final analysis.)

3. Seven officers who volunteered to be part of the research attended AI-1 programs hat were presented on a segmented basis.

MSU Highway Traffic Safety Programs presented the five-day AI-1 training programs in two formats. It was most frequently presented in five consecutive days (Monday through Friday). The second format for the five days of training was one day a week for five consecutive weeks (i.e., every Tuesday for five weeks). The seven who attended the segmented programs were not used in the final analysis to eliminate the possibility that differences in cognitive retention might exist as a result of training program format.

Approximately 3,500 Michigan police officers have attended MSU's AI-1 training. Only about 400 of the 3,500 attended the one-day-a-week segmented format. The remaining 3,100 attended AI-1 training programs presented in five consecutive day (Monday through Friday) format.

Performance Test Mean Scores by Variable Subcategories

The data collected from the participating subjects included performance retest scores, the number of months between original performance test and performance retest, age, education level, and the number of traffic accidents (personal injury and fatal) investigated during the 12 months preceding the performance retest.

Table 4.1 lists the variables used in this evaluation: original performance test, performance retest, time, age, education, and number of accidents investigated. Table 4.1 shows that:

1. The test subjects' mean score by percentage on the original performance test was 89.71, standard deviation 10.39, minimum score 72, and a maximum score of 100.

2. The test subjects' mean score by percent on the performance retest was 75.51, standard deviation 6.55, minimum score 55, and a maximum score of 100.

3. The test subjects' mean time in months since taking the original performance test was 47.85, standard deviation 40.61; the minimum time was 4 months, the maximum was 130 months.

4. The test subjects' mean age in years when taking the performance retest was 37.55, standard deviation 6.02; the minimum age was 24, the maximum age was 49.

5. The test subjects' mean education level in number of years of education beyond high school was 2.32, standard

deviation 1.23; minimum number of years was 1, the maximum was 6.

6. The test subjects' mean number of accidents investigated in the 12 months preceding the performance retest was 62.77, standard deviation 103.09, minimum number investigated was 0, and maximum was 486.

TABLE 4.1. Mean, Standard Deviation, Minimum Range, and Maximum Number for each of the Six Variables

VARIABLE	MEAN	S.D.	RANGE MINIMUM (N)	RANGE MAXIMUM (N)
Post test score (0/0)	89.71	6.55	72	100
Retest score (0/0)	75.51	10.39	55	100
Time in months	47.85	40.61	4	130
Age in years	37.55	6.02	24	49
Educ. in years	2.32	1.23	1	6
No. of Acc. Inv.	62.77	103.09	0	486

Summary and Comments: Table 4.1 Information

There was a difference of 14.2 percentage points between the post test (original test) and retest, with the original test being the higher. The standard deviation for the post test was lower; i.e., the test scores for the post test were more closely grouped than those of the retest resulting in a standard deviation of 10.39, or 3.84 higher than the post test. On the post test two of the 100 officers in the study sample scored 100 percent; however, it should be noted that of the approximate 3,500 officers who have taken the post test

over the past 12 years, only eight have scored 100 percent on the test. Only one officer scored 100 percent on the performance retest.

The variable of time for this evaluation was based upon the number of months that elapsed since the officer completed the original performance test. Based upon the mean and standard deviation of time, it can be seen that there was a wide spread from the shortest and longest period of time. Although the longest period of time was 130 months, there was only one officer with 90 or more elapsed months.

The only variable that had less deviation than age was education. Age measured in years had a standard deviation of 6.02 with a mean of 37.55; there was at least one subject in every age group between 24 and 49 years of age.

The variable of education had a range from one year of college to six years of college. Every officer in the test group had a high school education. The largest number of retest subjects had two years of college. Three retest subjects had more than four years of college; one officer had five years of college and only two officers had six years of education beyond high school. There were no test subjects who had more than six years of college.

The last variable in Table 4.1 is the number of accidents (personal injury and/or fatal) investigated by the test subjects in the year preceding the performance retest. The range was from 0 to 486 with a standard deviation of 103 accidents investigated. Most of the test subjects reporting

large numbers of accidents investigated were from the state's largest metropolitan departments where there were large numbers of traffic accidents and only a small traffic unit assigned to perform investigations. Out of the total research population of 100, 19 officers investigated more than 88 accidents and only five officers investigated 400 or more. There were 15 officers who did not investigate any accidents during the year preceding the performance retest.

Table 4.2 is a listing of the three subpopulations of the time variable. Information included is the mean score, the standard deviation of the performance retest for each subpopulation, and the number of cases in each subpopulation of the time variable. Table 4.2 shows that:

1. The test subjects who have an elapsed time of more than 4 months to 12 months since completing the original performance test had a mean score of 80.69, standard deviation of 10.32; a total of 26 subjects.

2. Test subjects who had an elapsed time of more than 12 months to 36 months had a mean score of 76.09, standard deviation of 10.05; a total of 31 subjects.

3. Test subjects who had an elapsed time of more than 36 months had a mean score of 72.02, standard deviation of 9.26; a total of 42 subjects.

TABLE 4.2 Performance Retest Mean, Standard Deviation, and Number of Cases for Each of the Three Subpopulations of the Time Variable

TIME/PERFORMANCE RETEST		MEAN	S.D.	CASES
1	More than 4 months to 12 months	80.69	10.32	26
2	More than 12 months to 36 months	76.09	10.05	31
3	More than 36 months	72.02	9.26	42

Summary and Comments: Table 4.2

The mean score of the performance retest is listed for each time period. The shortest time period, 4-12 months, had the highest mean score; 12-36 months had the next highest score, and 36 months or more had the lowest mean score. From the shortest time period to the longest, each category dropped approximately 4 percent; the regression of scores is consistent from time period to time period. The standard deviation only varied a few percentage points among all time categories.

Table 4.3 lists the three subpopulations of the education variable. Information included is the mean score, standard deviation of the performance retest for each subpopulation, and the number of cases in each subpopulation.

Table 4.3 shows that:

1. The test subjects who had a high school diploma but less than an associate degree had a mean score of 72.66 on the performance retest, standard deviation of 10.99; 33 test subjects were in this subpopulation.

2. Test subjects who had an associate degree but less than a four-year degree had a mean score of 77.19, standard deviation 9.99; 42 test subjects were in the subpopulation.

3. Test subjects who had a four-year degree or more than four years of college had a mean score of 76.44, standard deviation of 9.8; 25 test subjects were in the subpopulation.

TABLE 4.3 Performance Retest Mean, Standard Deviation and Number of Subjects for each of the Three Subpopulations of the Variable of Education

EDUCATION/PERFORMANCE RETEST		MEAN	S.D.	CASES
1	High school diploma but less than associate degree	72.66	10.99	33
2	Associate degree but less than four-year degree	77.19	9.99	42
3	Four-year degree or more	76.44	9.8	25

Summary and Comments: Table 4.3

Performance retest scores were the highest for the education level group that had an associate degree but less than a four-year degree; 42 of the total test group fell into this category. The four-year degree or more education level group did not do as well as the associate degree group; however, there was only .75 percent difference between the two levels. Both of the degree-level subjects scored approximately 4.5 percent higher than the group that had high school

diplomas. Standard deviation varied only 1.19 between the three education levels.

Table 4.4 lists the four subpopulations of the age variable. Information in the table includes the performance retest mean, standard deviation for each of the subpopulations, and the number of subjects in each subpopulation. Table 4.4 shows that:

1. Test subjects from 24 to 33 years of age had a mean score of 79.79, a standard deviation of 11.08 on the performance retest; a total of 24 subjects were included.

2. Test subjects 34 to 37 years old had a mean score of 73.07, standard deviation 8.25; 26 subjects were included.

3. Test subjects 38 to 42 years old had a mean performance retest score of 76.53, standard deviation of 11.22; 26 subjects were in this subpopulation.

4. Test subjects who were older than 42 years had a mean score of 72.75, standard deviation of 9.8; 24 subjects were in the subpopulation.

TABLE 4.4 Performance Retest Mean Score, Standard Deviation and Number of Subjects for each of the Four Subpopulations of the Age Variable

AGE/PERFORMANCE RETEST		MEAN	S.D.	CASES
1	24 to 33 years	79.79	11.08	24
2	34 to 37 years	73.07	8.25	26
3	38 to 42 years	76.53	11.22	26
4	43 years or older	72.75	9.8	24

Summary and Comments: Table 4.4

The effect of age on the performance retest shows some inconsistent variations among the four divisions. There were one or more officers in each year for the range of 24 to 49 and as table 4.4 shows, the study sample of 100 was almost evenly distributed among the four age divisions. The youngest group and the next-to-oldest group had the highest performance retest scores and these same two groups also had the highest standard deviation. Ages 34 to 37 years of age (next to the youngest group) and the oldest group of 43 years or more had the lowest retest scores but a smaller standard deviation.

Table 4.5 lists the five subpopulations of the number of accidents investigated in the year preceding the performance retest. Information in the table includes the performance retest mean score, standard deviation, and number of subjects in each subpopulation. Table 4.5 shows that:

1. Test subjects who investigated no accidents in the preceding 12 months had a performance retest mean score of 69.84, standard deviation 8.78; 13 subjects were in this subpopulation.

2. Test subjects who investigated 1-10 accidents had a mean score of 77.80, standard deviation of 11.30; 21 subjects were in this subpopulation.

3. Test subjects who investigated 11-30 accidents had a mean score of 75.37, standard deviation of 10.65; 24 subjects were in this subpopulation.

4. Test subjects who investigated 37-65 accidents had a mean score of 81.55, standard deviation of 9.45; 20 subjects were in this subpopulation.

5. Test subjects who investigated 66 or more accidents had a mean score of 71.31, standard deviation of 7.76; 22 subjects were in this subpopulation.

TABLE 4.5 Performance Retest Mean Score, Standard Deviation and Number of Subjects for each of the Five Subpopulations

ACCIDENTS INVESTIGATED/ PERFORMANCE RETEST		MEAN	S.D	CASES
1	No accidents investigated	69.84	8.78	13
2	1-10 accidents investigated	77.80	11.30	21
3	11-30 accidents investigated	75.37	10.65	24
4	31-65 accidents investigated	81.55	9.45	20
5	66 or more accidents investigated	71.31	7.76	22

Summary and Comments: Table 4.5

Zero to 486 accidents were investigated by individual officers during the year preceding the performance retest. Test subjects who investigated zero accidents had the lowest mean score and also the next-to-lowest standard deviation. A mean score for the officers who were in the division of 66 or more accidents investigated (or an actual range of 66 to 486)

had the smallest standard deviation of the five divisions and also had the next-to-lowest mean score. The mean percentage score of the two groups varied by only 1.47 percent. The lower mid-range groups of 1-10 and 11-30 accidents investigated had mean scores that varied by 2.43 percent and a variance in standard deviation of only .65 percent. The division of officers who investi-gated 31-65 accidents had the highest mean score, 11.71 percent more than the lowest mean score.

Differences between Mean Original Performance Test and Performance Retest

The following directed hypothesis was tested for the combined mean scores of the 100 test subjects:

Hypothesis 1: The total sample of officers when treated as one group will show significant loss of retention as calculated by the performance retest.

At the end of each training program each student was given an original performance test (post test). At the beginning of each follow-up testing session a performance retest (same as post test) was given to 100 previously AI-1 trained officers. The maximum possible score on each test was 100. Table 4.6 provides a statistical analysis of the two tests.

To determine whether a significant loss in the mean score of the original performance test occurred, as compared to the mean score of the performance retest, a paired sample t-test analysis was used. The .05 level of significance was selected as the basis for accepting or rejecting the hypothesis. The

critical value of the t-statistic in this test was the .05 significance level and the calculated t-statistic was .00. Table 4.6 shows that:

1. The 100 test subjects had a mean score of 89.71 on the original performance test and a mean score of 75.51 on the performance retest. The respective standard deviations were 6.55 and 10.39. The difference of the means was 15.07.

2. The t-value was 14.20 with 99 degrees of freedom, the critical t value was 1.661.

3. The tail probability was .00, with the level of significance set at .05. This means that the directional hypothesis was not rejected.

TABLE 4.6 Comparison of the Mean Test Scores of the 100 Subjects for the Original Performance Test and the Performance Retest

	N	MEAN	SD	DM	t-VALUE	df	CF	2-TAIL PROBABILITY
Original test	100	89.71	6.55					
				15.07	15.45	99	1.661	.00
Retest	100	75.51	10.39					

N	=	Number of subjects in study
MEAN	=	Mean scores of the two tests
SD	=	Standard Deviation
DM	=	Difference between the two means
t-VALUE	=	Computed t value
df	=	Degrees of freedom
CF	=	Critical t value
TAIL PROBABILITY	=	Level of significance

Summary and Comments: Table 4.6

Hypothesis 1 stated that the mean score of the original performance test would be significantly higher than the performance retest mean. Not only was the original test 14.2 percent higher, the standard deviation was 3.84 points lower than the retest standard deviation. This means that the retest scores were both lower and less consistent than the original performance test scores.

The Effect of time on the Performance Retest Mean Score

The following hypothesis was tested to determine if varying periods of elapsed time since taking the original performance test had an affect on the performance retest:

> Hypothesis 2: When dividing the total sample of tests of the officers into three groups based upon interval of time since completing the AI-1 training program, officers' retention levels will vary significantly as reflected by the group mean score on the performance retest.

To determine whether the mean of the performance retest was influenced by the main effect of time, the scores and three time periods were examined through the use of analysis of covariance. With the analysis of covariance controlling the possible effect of the original performance score, positive or negative results of the analysis can be attributed to the effect of time.

The 100 subjects' tests were divided by the following time segments:

Group 1 = Four to 12 months since tests were taken

Group 2 = More than 12 months to 36 months since tests were taken

Group 3 = More than 36 months since tests were taken

Table 4.7 provides the results of the analysis of the performance retest by time with the results of the original performance test being controlled through use of covariance. Table 4.7 shows that:

1. There were 2 degrees of freedom; the sum of the squares was 1235.96 with a mean square of 617.981.

2. The computed value of F is 9.031; its critical value at a .05 significance level was 3.103

3. The probability area is .00. The hypothesis was not rejected.

TABLE 4.7 Analysis of Covariance of the Performance Retest by the Divisions of Time

df	SUM OF SQUARES	MEAN SQUARE	COMPUTED VALUE OF F	CRITICAL VALUE OF F at .05	COMPUTED SIGNIFICANCE OF F
2	1235.96	617.981	9.031	3.103	.00

Table 4.8 provides additional detail of the three periods of time and provides the basis for not rejecting the hypothesis. Table 4.8 shows that:

1. The grand mean of the three groups was 75.65.

2. The unadjusted by analysis of covariance plus-or-minus value for the grand mean were Group 1 = 5.32, Group 2 = .45, and Group 3 = -3.62.

3. The adjusted by analysis of covariance plus-or-minus values for the grand mean were Group 1 = 4.86, Group 2 = 1.01, and Group 3 = -3.75.

TABLE 4.8 The Effect of Time on the Grand Mean as Determined by the Analysis of Covariance

TIME GROUP	GRAND MEAN	UNADJUSTED AMOUNT	ADJUSTED AMOUNT	NEW GRAND MEANS U	A
1	75.65	5.32	4.86	80.97	80.51
2	75.65	.45	1.01	76.1	76.66
3	75.65	-3.62	-3.75	72.03	71.9

GROUP 1 = Four months to 12 months since tests were taken
GROUP 2 = More than 12 months to 36 months since tests were taken
GROUP 3 = More than 36 months since tests were taken

Grand Mean = Mean of N100
Unadjusted Amount = Difference + or - to grand mean with no control for possible effect of original performance test
Adjusted Amount = Difference + or - to grand mean when controlling for possible effect of original performance test
U & A = New means per group when adding or subtracting the unadjusted (U) and adjusted (A) amounts

Summary and Comments: Tables 4.7 and 4.8

Data in Tables 4.7 and 4.8 address the directed hypothesis that the variable of time had an effect on the performance retest and that retention levels varied significantly as reflected by the group mean score. Table 4.7 lists the results of the use of analysis of covariance which controls for the possible effect that the original performance test may have on the outcome of the analysis. As a result, the differences in the mean scores are the result of time, not the original post test scores. The .00 significance level listed in Table 4.7 indicates that there were significant differences among the three time periods.

The data in Table 4.8 provides additional results of the analysis by showing the grand mean for the total N=100. The analysis of covariance adjusted grand mean ranges from 4.86 percent for group 1 to -3.75 for group 3 or a difference of 8.61 percent. If the analysis of covariance was not used the ranges would be 5.32 percent to 3.62 percent or a difference of 8.94 percent.

The Effect of Education on the Performance Retest Mean Score

The following hypothesis was tested to determine if varying levels of education affect the performance retest:

Hypothesis 3: Officers' education level will not show a significant relationship with the performance retest scores.

To determine the possible effect on the mean of the performance retest with the main effect of education, the

scores and education levels were tested by the analysis of covariance. The 100 test subjects were divided by the following education levels.

1. Less than two years of college
2. Associate degree but less than four years of college
3. Four-year-degree or more

Table 4.9 contains the sum of the squares, mean square, degrees of freedom, the F values computed on the means of the performance retest, and significance level with the main effects of education. Table 4.9 shows that:

1. There were 2 degrees of freedom, the sum of the squares was 135.59 with a mean square of 67.79.
2. The computed value of F was .813; its critical value at a .05 significance level was 3.10.
3. The probability area was .447 which is larger than the .05 level. The hypothesis was not rejected.

TABLE 4.9 Analysis of Covariance of the Performance Retest by the Three Divisions of Education

df	SUM OF SQUARES	MEAN SQUARE	COMPUTED VALUE OF F	CRITICAL VALUE OF F at .05	COMPUTED SIGNIFICANCE OF F
2	135.59	7.79	.813	3.10	.447

Table 4.10 provides additional details for the three divisions of education and provides the basis for not rejecting the hypothesis. Table 4.10 shows that:

1. The grand mean of the three groups by education was 75.51.

2. The unadjusted by analysis of covariance plus-or-minus values for the grand mean were Group 1 = -2.84, Group 2 = 1.68, and Group 3 = .93.

3. The adjusted by analysis of covariance plus-or-minus values for the grand mean were Group 1 = -1.68, Group 2 = .83, and Group 3 = .83.

TABLE 4.10 The Effect of Education on the Grand Mean as Determined by the Analysis of Covariance

EDUCATION DIVISION	GRAND MEAN	UNADJUSTED AMOUNT	ADJUSTED AMOUNT	NEW GRAND MEANS U	A
1	75.51	-2.84	-1.68	72.67	73.83
2	75.51	1.68	.83	77.19	76.34
3	75.51	.93	.83	76.44	76.34

GROUP 1 = Less than 2 years of college
GROUP 2 = Associate degree but less than a four year degree
GROUP 3 = Four-year-degree or more

Grand Mean	=	Mean of N100
Unadjusted Amount	=	Difference + or - to grand mean with no control for possible effect of original performance test
Adjusted Amount	=	Difference + or - to grand mean with controlling for possible effect of original performance test
U & A	=	New means per group when adding or subtracting the unadjusted (U) and adjusted (A) amounts

Summary and Comments: Tables 4.9 and 4.10

Table 4.9 data indicate that the directed hypothesis of officers' education level will not show a significant relationship with the performance retest scores; the hypothesis was not rejected. A .05 level of significance was chosen and the analysis of covariance determined the significance level to be .447.

Table 4.10, as does Table 4.8, lists the percentage that the mean scores of N=100 must be adjusted when the total is divided into three groups and the analysis of covariance is applied. The adjustment amounts of -1.68 for Group 1, .83 for Group 2, and .83 for Group 3 show a trend but not as strong as the trend in Table 4.8. The unadjusted amounts in Table 4.10 show a stronger trend; this indicates the value of the analysis of covariance which determines that amount of education did not significantly affect the mean of the performance retest scores.

The Effect of Test Subjects' Age on the Performance Retest Mean Score

The following hypothesis was tested to determine whether varying ages of the test subjects affected the performance retest:

Hypothesis 4: Officers' age will not show a significant relationship with performance retest scores.

To determine the possible influence on the mean of the performance retest with the main effect of age groupings, the scores and age divisions were tested using analysis of

covariance. The 100 test subjects were grouped by the following age levels.

Group 1 = 24 to 34 years of age

Group 2 = More than 34 to 37 years of age

Group 3 = More than 37 to 42 years of age

Group 4 = More than 42 years of age

Table 4.11 contains the sum of the squares, mean squares, degrees of freedom, the F values computed on the mean of the performance retest, and significance level with the mean effect of age. Table 4.11 shows that:

1. There were 3 degrees of freedom; the sum of the squares is 3029.86 with a mean square of 757.46.

2. The computed value of F was 1.972; its critical value at a .05 significance level was 2.70.

3. The probability area is .123 which is greater than the significance level of .05. The age of the officer does not make a difference; therefore, the hypothesis was not rejected.

TABLE 4.11 Analysis of Covariance of the Performance Retest by the Division of Age

df	SUM OF SQUARES	MEAN SQUARE	COMPUTED VALUE OF F	CRITICAL VALUE OF F at .05	COMPUTED SIGNIFICANCE OF F
3	444.49	159.16	1.972	2.70	.123

Table 4.12 provides additional details for the four age divisions and provides the basis for not rejecting the hypothesis. Table 4.12 shows that:

1. The grand mean of the four groups by age was 75.51.

2. The unadjusted amount by analysis of covariance plus-or-minus values for the grand mean were Group 1 = 4.28, Group 2 = -2.43, Group 3 = 1.03, and Group 4 = -2.76.

3. The adjusted amount by analysis of covariance plus-or-minus values for the grand mean were Group 1 = 3.16, Groups 2 = -1.86, Group 3 = 1.07, and Group 4 = -2.30.

TABLE 4.12 The Effect of Age on the Grand Mean as Determined by Analysis of Covariance

AGE DIVISION	GRAND MEAN	UNADJUSTED AMOUNT	ADJUSTED AMOUNT	NEW GRAND MEANS	
				U	A
1	75.51	4.28	3.16	79.79	78.67
2	75.51	-2.43	-1.86	73.08	73.65
3	75.51	1.03	1.07	76.54	75.58
4	75.51	-2.76	-2.30	72.75	73.21

Summary and Comments: Tables 4.11 and 4.12

Table 4.11 shows the result of the analysis of covariance of the performance retest by age divisions. The results placed the significance level at .123. The F of .123 exceeded the selected significance level of .05. The hypothesis for the effect of an officer's age was written in a directed

fashion as a result of the Chapter 2 literature review; therefore, the hypothesis was not rejected.

Table 4.12 is additional documentation of why an officer's age did not bear a significant relationship to the performance retest. Analysis of covariance was used to control the effect of the original performance test to determine the effect of age on the performance retest. The primary results of this type of analysis were listed under the column "adjusted amount" in table 4.12. The 3.16, -1.86, 1.07, and -2.30 are the percentage points used for the respective age divisions of 1 to 4 to adjust the grand mean of 75.51 percent. The adjustment amounts show no trend to support the regression of scores based upon age; therefore, age was not a significant variable on performance retest scores.

The Effect of the Number of Accidents Investigated on the Performance Retest Mean Score

The following hypothesis was tested to determine whether the performance retest was affected by the number of accidents investigated by the test subjects during the previous 12 months:

Hypothesis 5: The number of personal injury and/or fatal vehicle traffic crashes investigated by officers during the one year period prior to taking the performance retest will show a significant positive relationship with the mean scores on the performance retest.

To determine the possible influence on the mean of the performance retest with the main effect of the number of traffic crashes investigated, individual scores and the five subgroups were tested by the analysis of covariance. The test subjects were divided into the following five groups.

Group 1 = No accidents investigated

Group 2 = 1-10 accidents investigated

Group 3 = 11-30 accidents investigated

Group 4 = 31-65 accidents investigated

Group 5 = 66 or more accidents investigated

TABLE 4.13 Analysis of Covariance of the Performance Retest by the Division of Number of Accidents Investigated 12 months prior to the Retest

df	SUM OF SQUARES	MEAN SQUARE	COMPUTED VALUE OF F	CRITICAL VALUE OF F at .05	COMPUTED SIGNIFICANCE OF F
4	711.037	177.759	2.248	2.50	.070

Table 4.13 contains the sum of the squares, mean squares, degrees of freedom, the F values computed on the mean of the performance retest, and significant level with the main effect of number of accidents investigated. Table 4.13 shows that:

1. There were 4 degrees of freedom; the sum of the squares was 711.037 with a mean square of 177.759.

2. The computed value of F is 2.248; its critical value at a .05 significance level was 2.50.

3. The probability area was .070 which was greater than the significance level of .05, which means that the number of accidents investigated during the 12 months preceding the performance retest was not significant; therefore, the hypothesis was rejected.

Table 4.14 provides additional details for the five divisions of number of accidents investigated and provides the basis for the nonsignificant finding. Table 4.14 shows that:

1. The grand mean of the five groups by number of accidents investigated was 75.51.

2. The unadjusted by analysis of covariance plus or minus values for the grand mean were Group 1 = -5.66, Group 2 = 2.30, Group 3 = -.13, Group 4 = 6.04, and Group 5 = -4.19.

3. The adjusted by analysis of covariance plus-or-minus values for the grand mean were Group 1 = -2.50, Group 2 = 1.50, Group 3 = .20, Group 4 = 3.97, and Group 5 = -3.81.

TABLE 4.14 The Effect of Number of Accidents Investigated on the Grand Mean as Determined by Analysis of Covariance

NO. OF ACCIDENTS INVESTIGATED DIVISION	GRAND MEAN	UNADJUSTED AMOUNT	ADJUSTED AMOUNT	NEW GRAND MEANS U	A
1	75.51	-5.66	-2.50	69.85	73.01
2	75.51	2.30	1.50	77.81	77.01
3	75.51	-.13	.20	75.38	75.71
4	75.51	6.04	3.97	81.55	79.48
5	75.51	-4.19	-3.81	71.32	71.7

Summary and Comments: Tables 4.13 and 4.14

Table 4.13 shows that the significance level of the effect of the number of accidents investigated on the performance retest was at a .07 level. A significance level of .05 was selected for this study; if a .10 level had been chosen then the .07 would have been significant.

Table 4.14 provides additional detail about the relationship of the number of accidents investigated on the performance retest scores. Looking at the percent adjustment to the grand mean, the adjusted amount (from 1 to 5) was -2.50, 1.50, .20, 3.97, and -3.81. Division 1 is zero accidents investigated and Division 5 is 66 or more accidents investigated. Both Divisions 1 and 5 show a negative amount, which does not show normal regression or related consistency. Division 2 (1-10 accidents), Division 3 (11-30 accidents), and Division 4 (31-65 accidents) provide some indication that as more accidents are investigated there is an increase in performance retest scores. The analysis procedure chosen for this research evaluated the effects of all divisions of accidents investigated and the results of that analysis indicate that the number of accidents investigated does not have a significant effect (.05 level) on the mean score of the performance retest.

Review of the Results of the Analysis of Hypotheses 1-5

The preceding pages included the analysis of the five hypotheses proposed for this study. Variables of time,

education, accidents investigated, age and original performance test were compared to the performance retest. The results of the five tests were:

Hypothesis 1: The total sample of officers when treated as one group will show a significant loss of retention as calculated by the performance retest.

This directional hypothesis was not rejected; there was a significant loss of retention based upon a comparison of the original performance test and the performance retest.

Hypothesis 2: When dividing the total sample of officers into three groups based upon interval of time since completing the AI-1 training program, officers' retention levels will vary significantly as reflected by the group mean score on the performance retest.

This directional hypothesis was not rejected; there was a significant loss of retention based upon the three separate time periods as compared to the performance retest.

Hypothesis 3: Officers' education level will not show a significant relationship with the performance retest scores.

This directional hypothesis was not rejected; there was not a significant relationship between the officers' education level and the performance retest scores.

Hypothesis 4: Officers' age will not show a significant relationship with performance retest scores.

This directional hypothesis was not rejected; age did not have a significant relationship with the performance retest mean score.

Hypothesis 5: The number of personal injury and/or fatal vehicle traffic crashes investigated by officers during the one-year period prior to taking the performance retest will show a significant positive relationship with the mean score on the performance retest.

This directional hypothesis was rejected; the number of accidents investigated by an officer during the preceding year prior to taking the performance retest was not significant in terms of the relationship to the performance retest.

Each hypothesis in this research was directed. The direction was based upon information obtained in the literature review in Chapter 2 of this research. The first four hypotheses were directed at (1) test/pretest, (2) time, (3) education, and (4) age were not rejected. The fifth hypothesis dealing with the number of investigations was rejected.

The five research hypotheses, which were the basis for this research, were discussed in detail in the preceding pages of this chapter. The remainder of Chapter 4 includes three areas of additional analyses of the same variables of performance retest scores, time in months since completing the AI-1 training, officer education level, age, and the number of accidents investigated during the year preceding the performance retest. Analysis of covariance and paired sample t-tests were also used for the additional analysis.

Analysis for the five research hypothesis evaluated the possible effect of the single variables of time, education, age, and number of accidents investigated on the performance retest scores. Various combinations of the variable were used

in the additional research to determine whether two variables together showed a significant relationship with the performance retest. The following combinations were tested:

		Main Effects	Covariate
1.	A	Time since completing AI-1	Performance Retest Score
	B	Education level	
2.	A	Time since completing AI-1	Performance Retest Score
	B	Age	
3.	A	Time since completing AI-1	Performance Retest Score
	B	Number of accidents investigated in year preceding performance retest	

Other combinations of main effects such as "education and age," "number of accidents investigated," and "age plus other combinations" were also analyzed.

The primary problem encountered in this analysis was that the total sample size was too small. As a result of the additional division of the N=100, cell size in many of the analyses dropped below five. The reliability of the analysis is suspect when cell size becomes this small. Cell size was discussed in Chapter 3, and it was determined that data generated by a cell size of less than five would not be used in this research.

The Combined Effect of Time and Education on the Performance Retest Mean Score

To determine whether the mean score of the performance retest was influenced by the combined main effects of time and education, all times and all education levels were examined

through the use of analysis of covariance. With the analysis of covariance controlling the possible effect of the original performance score, positive or negative results of the analysis can be attributed to the combined effects of time and education.

TABLE 4.15 Analysis of covariance of the Performance Retest by All Time and All Education Levels

	df	SUM OF SQUARE	MEAN SQUARE	COMPUTED VALUE OF F	CRITICAL VALUE OF F at .05	COMPUTED SIGNIFICANCE OF F
Main Effects	4	1297.75	324.43	4.712	2.49	.002
Time	2	1227.78	613.89	8.916	3.11	.000
Education	2	61.79	30.89	.449	3.11	.640

Table 4.15 shows the results of the analysis described above:

1. There were 4 degrees of freedom, 2 each for time and education; the sum of the squares was 1297.75 for main effects, 1227.78 for time and 61.79 for education with main effects, 1227.78 for time and 61.79 for education with mean squares of 324.43 for main effects, 613.89 for time, and 30.89 for education.

2. The computed value of F was 4.712 for main effects, 8.916 for time and .449 for education; the critical value of

F at a .05 significance level for main effects is 2.49, time 3.11, and education 3.11.

3. The probability area for main effects was .002, time .000 and education .640, which means that main effects are significant, time was significant, but education was not significant.

Summary and Comments: Table 4.15

Data in Table 4.15 show the combined effect of all time and all education on the performance retest. The table contains the levels of significance and a .002 was significant for the combined effects of time and education. Looking at individual levels of significance, it can be seen that time was significant but education was not. The results of the analysis show that the effect of time causes the main effect to be significant. There was not a two-way interaction between time and education. Hypothesis 3 dealt with the variable of education, and the analysis indicated that there was not a significant relationship between education and the performance retest. Hypothesis 2 dealt with the variable of time, and the analysis of that variable indicated that there was a significant loss of retention based upon the three separate time periods as compared to the performance retest.

The Combined Effect of Time and Number of Accidents Investigated on the Performance Retest Mean Score

To determine whether the mean score of the performance retest was affected by the combined main effects of time and

number of accidents investigated, all time and all divisions of accidents investigated were examined through the use of analysis of covariance. With the analysis of covariance controlling the possible effect of the original performance score. Positive or negative results of the analysis can be attributed to the combined effects of time and education.

TABLE 4.16 Analysis of Covariance of the Performance Retest by All Time and All Accidents Investigated

	df	SUM OF SQUARE	MEAN SQUARE	COMPUTED VALUE OF F	CRITICAL VALUE OF F at .05	COMPUTED SIGNIFICANCE OF F
Main Effects	6	1739.217	289.869	4.384	2.33	.001
Time	2	1189.693	594.864	8.997	3.11	.000
Number of Acc. Inv.	4	503.256	125.814	1.903	2.72	.118

Table 4.16 contains the results of the analysis described above:

1. There were 6 degrees of freedom, 2 for time and 4 for the number of accidents investigated. The sum of the squares was 1739.21 for the main effects, 1189.69 for time and 503.25 for the number of accidents investigated; mean squares of 289.86 for the main effects, 594.86 for the variable of time and 125.81 for the variable of the number of accidents investigated.

2. The computed value of F for the main effects was 4.384, variable of time was 8.997, and number of accidents investigated is 1.903. The critical value at a .05 significance level for the main effects was 2.33, time was 3.11, and number of accidents investigated was 2.72.

3. The probability area for the main effects was .001, time was .000, and the probability of number of accidents investigated was .118. This means that the main effect of time was significant, but the number of accidents investigated in the year preceding the performance retest was not significant.

Summary and Comments: Table 4.16

Data in Table 4.16 address the combined effect of all time and all numbers of accidents investigated during the year preceding the performance retest. The main effects of the combination of time and accidents investigated was significant at a level of .001. Looking at the significance level individually, time was significant but the number of accidents investigated was not. The main effects were significant. Time was more significant than the number of accidents investigated, but combining the two variables made the main effects significant. Although the main effects were significant at a .001 level, there was not a two-way interaction between the variable of time and number of accidents investigated. Hypothesis 2 addresses the variable of time, and the analysis of the variable indicated that there was a

significant loss of retention based upon the three divisions of time. Hypothesis 5 addressed the variable of number of accidents investigated during the year preceding the performance retest. That hypothesis was rejected; the number of accidents investigated was not significant in terms of its effect on the performance retest.

The Combined Effect of Time and Age on the Performance Retest Mean Score

To determine whether the mean score of the performance retest was affected by the combined main effects of time and age, all times and all ages were evaluated through the use of analysis of covariance. With the analysis of covariance controlling for the possible effect of the original performance score, any effect that the analysis shows can be attributed to the combined effects of all times and all age groups.

Table 4.17 shows the results of the analysis described above:

1. There were five degrees of freedom, two for time and three for age; the sum of the squares was 1343.8 for main effects, 941.317 for the variable of time and 107.839 for the variable of age. The mean square for the main effects was 268.76, time had a mean square of 470.658, and age was 35.946.

2. The computed value of F was 4.366 for the main effects, 7.646 for time and .584 for age. The critical value at a .05 significance level for main effects was 2.21, time 3.11, and age 2.49.

3. The probability area for main effects was .001, time was .001 and age was .627. This means that the main effects are significant, time was significant, and age was not significant.

TABLE 4.17 Analysis of Covariance of the Performance Retest by All Times and All Age Levels

	df	SUM OF SQUARE	MEAN SQUARE	COMPUTED VALUE OF F	CRITICAL VALUE OF F at .05	COMPUTED SIGNIFICANCE OF F
Main Effects	5	1343.8	268.760	4.366	2.21	.001
Time	2	941.317	470.658	7.646	3.11	.001
Age	3	107.839	35.946	.584	2.49	.627

Summary and Comments: Table 4.17

Data in Table 4.17 show the combined effect of all time periods and all age levels on the means of the performance retest scores. The table lists the levels of significance, a .001 is significant for the combined effects of time and age. Looking at the individual levels of significance, it can be seen that time was significant at .001 and age was not significant at a .627 level. The main effects were significant as a result of the stronger level of significance of the variables of time. There was not a two-way interaction between time and age. Hypothesis 2 addressed the variable of time, and the analysis of that variable indicated that there was a significant loss of retention based upon the three

separate time periods on the performance retest. Hypothesis 4 addressed the variable of age, and it was determined that age did not have a significant effect on the performance retest score.

The paired samples of time and the variables of age, education, and number of accidents investigated were significant due to the strong significance level of time. The variable of time continued to be a significant factor in all tests, even though sample size was smaller when comparing two variables instead of only one, as was done in the five hypotheses.

Summary

The findings of the investigation were presented in this chapter. These findings showed the relationship that time, education, age, and number of accidents investigated analyzed singly had with the mean of the performance retest scores. Also presented were the combined effects that time and education, time and age, and time and the number of accidents investigated had on the mean of the performance retest scores. The following chapter contains the summary, conclusions' and recommendations.

Chapter 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The findings of this investigation were presented in the preceding chapter. This chapter contains: a summary of the investigation, conclusions based upon the findings, recommendations, recommendations for further research and implications.

Summary

Purpose

The writer's purpose in this study was to investigate the degree to which cognitive knowledge gained by Michigan police officers in the Michigan State University Accident Investigation 1 (AI-1) training program was retained over varying periods of time. The problem was that, until now, no attempt had been made to measure the retention of AI-1 cognitive knowledge once the officer was back in the field and performing his/her assigned duties in the field. This investigation was designed to answer the following questions:

1. Is there a significant difference between the computed mean score of the original performance test taken by the police officers included in this study at completion of

their respective AI-1 program as compared to the mean score of the performance retest taken by the same group of officers?

2. Is there a significant difference in mean scores based upon the amount of elapsed time since completion of AI-1 training.

3. Is there a significant difference in mean scores of the original performance test and the performance retest based upon the education level of individual officers.

4. Is there a significant difference between officers' age and retention based upon the means of the performance retest and original performance test.

5. Is there a significant difference between the officers retention level and test mean scores based upon the number of accidents the officers investigated during the year preceding the performance retest.

The Research Methods and Procedures

During spring and summer 1989, 100 police officers who completed the AI-1 training program volunteered to retake the AI-1 post test. The officers who volunteered to retake the test were attending other MSU training programs in the Michigan counties of Oakland, Wayne and Macomb. Other officers who volunteered to take the retest were police officers from the Eaton and Ingham County Sheriff Departments.

Each volunteer completed a questionnaire that requested specific information about age, education level, elapsed time since completing AI-1, and number of accidents investigated

during the year preceding their participation in this evaluation. Once the test and questionnaire had been completed, the data were tabulated and placed on a summary sheet. Other information placed on the summary sheet was the date that each volunteer completed AI-1 and also his/her post test score obtained at completion of the AI-1 training program attended.

Summary data were divided by age categories, educational levels, number of accidents investigated, elapsed months between the two tests and original performance score (post test) and performance retest scores. The groups were compared by using paired sample t-tests and the analysis of covariance to determine whether there was a significant difference between the mean scores based upon the variables of time, education, age and number of accidents investigated.

Major Findings

The major findings of this investigation were:

1. The total sample of 100 subjects, when treated as one group with no sub-divisions, showed a significant loss of retention based upon a comparison of the mean scores of the original performance test and the performance retest.

2. When the total sample was divided into various time periods since completing the AI-1 training program, the analysis showed that, the longer the elapsed time since taking the training, the lower the retest score.

3. Based upon the analysis of officer education level and the performance retest mean score, there was not a significant relation between education level and mean score.

4. The analysis, based upon officer age and its relationship to the performance retest mean score, showed that a significant relation did not exist.

5. The number of accidents investigated by officers during the year preceding the performance retest was not significant in terms of its relationship to the performance retest.

Conclusions

The following conclusions are based upon the general findings of this investigation.

1. Of the variables included in the investigation, the overall most significant one was the amount of elapsed time for the officer between taking the original performance test and the performance retest. Three time divisions were used. The shortest division included the time period of 4 months to 12 months. This group had the highest performance retest mean score. This finding was supported by the results of the literature review in Chapter 2. The mean of the performance retest scores for each successively longer time period regressed at a consistent rate, with the longest elapsed time group achieving the lowest performance retest score. Standard deviation scores for the three time periods were very consistent and all were within 1.06 percentage points of each other.

Time is a significant factor and the results of this research show that cognitive knowledge gained during the AI-1 training program is not fully maintained over varying periods of time. The longer the elapsed time period since completing the AI-1 training equals less retention of cognitive knowledge.

2. The variable of officer education level had no significant effect on the mean of the performance retest. There was no correlation between the three levels of education. Officers with a high school diploma and less than two years of college had the lowest performance retests mean score. Officers with an Associate Degree but less than a four-year degree had a mean score higher than officers with less than two years of college and also higher than officers with a four-year degree or more. As a result, there was not a significant correlation between the three levels of education; therefore, a significant relationship does not exist between education and the mean of the performance retest.

3. An age range of 24 to 43 years of age existed for the one hundred test subjects in this investigation. It was determined that age of the individual officers did not have a significant relationship to the mean score on the performance retest. The youngest age group had the highest mean score and the oldest group had the lowest mean score. These two age groups had what could be expected in terms of the possible effect of age on retention, however, the two age groups between the youngest and oldest offered no resemblance of a significant correlation in conjunction with the other age

divisions. Therefore, the variation between the performance retest mean scores for the various age levels were not significant.

4. Overall, the relationship between number of accidents investigated during the year preceding the performance retest and the performance retest mean score did not reach significance. However, there was some correlation between the mean scores of the five divisions of number of accidents investigated. Division 1 (no accidents investigated during the year preceding the performance retest) had the lowest adjusted mean score. Based upon the literature review, a lower score could be expected of those who do not utilize their knowledge. However, Division 5, the group with the largest number of accidents investigated, had the lowest performance retest mean score. This result cannot be explained based upon the investigation or information contained in the literature review. It is known that the officers in the division with the largest number of accidents investigated were from Michigan's largest police departments, where officers have many other assignments and their jurisdictions have high traffic volumes and high accident ratios. It would be useful to investigate the possible relationship between size of department, number of accidents investigated and AI-1 training cognitive knowledge retained over time.

5. Analysis to show the results of combining variables to determine their relationship to the mean of the performance

retest was made. Combined variables of (1) time and education, (2) time and number of accidents, and (3) time and age resulted in time continuing to be significant in combination with education and number of accidents investigated but not in combination with age. As a result of the strong significance level of time, the main effects in all three tests were also significant.

6. The hypotheses investigated in this research were formulated on the general findings of the literature review, Chapter 2. Each hypothesis was directed or based upon the expected outcome as determined by the literature review. Previous researchers have suggested that time would be a significant factor in the retention of cognitive knowledge, and it proved to be in this study, as well. Officer age and education level and number of accidents investigated were found not to be significant, based upon the directed hypotheses concerning these variables.

Recommendations

Based upon this research, as well as the researcher's experience in accident investigation, such as training approximately 4,000 Michigan police officers in AI-1, reviewing reports of AI-1 graduates and assisting them in their investigations, the following recommendations are made:

1. Time is a critical variable in AI-1 cognitive knowledge retention. Refresher AI-1 training should be required of all police officers who have the responsibility of

investigating accidents. An officer should receive refresher training every two years.

2. Refresher training should include the primary areas of roadway evaluation, measuring, sketching and photography.

3. Refresher AI-1 training should be included in the form of role call training. A 15-minute video tape on each of the four subjects identified in Recommendation 2 would "sharpen" the officers' skills in these four critical areas of recording information.

4. Investigation of large numbers of accidents does not improve cognitive knowledge retention. Officers should receive refresher training regardless of the number of accidents they investigate in any given time period.

5. "Use it or lose it" is a viable concept. An officer who has not had AI-1 training for three or more years and has not been assigned to accident investigation duty should not be permitted to perform full-scale investigations. An officer in this category needs more than roll-call training. He/she should be required to have a one-day (eight hours) review and/or update program on AI-1 subjects.

6. Age is not a significant factor in police officer cognitive knowledge retention of AI-1 training information. Provided that he/she has completed AI-1 training, has been continually assigned to investigate accidents and receives the recommended AI-1 role call training, a police officer should not be removed from the duty of investigating accidents solely because of age.

7. Advanced college degree requirements of more than an associate's degree should not be mandatory for an officer to gain entry to a police departments traffic unit. However, once officers are in the traffic unit they should be encouraged to continue their education.

Recommendations for Future Research

1. This investigation should be repeated, taking into consideration:

   a. using test subjects who have all completed the same level of additional AI training programs, i.e., all officers who have completed AI-1 through AI-8.

   b. using two sets of test subjects, one group consisting of officers who have general police responsibility in addition to accident investigation and the second group consisting of officers who are assigned the specific task of accident investigation and traffic enforcement.

   c. using test subjects similar to the ones used in this research with the additional variables of size of department and accident ratios for the individual departments.

2. Follow-up research to this evaluation should be completed in the form of an item analysis of each test question in the post test. This would help identify other cognitive knowledge areas in which an officer becomes weaker through time.

Implications

The research, analysis, and findings based on the study have implications in the following areas.

Training and Recertification

The variables reviewed in this study and the findings can benefit the traffic services related function in law enforcement. For various reasons, AI-trained police officers are temporarily transferred to other assignments. The question of concern is: When the officer is returned to a traffic-related role, is he/she still qualified to perform traffic-related duties? The Michigan Law Enforcement Officers Training Council, which sets training standards, is faced with the problem of deciding how often an officer should be sent to recertification school. This writer suggests that time is a variable that should be considered when organizations and individuals have to answer this type of question. How long it has been since the officer received training and how many accidents the officer has investigated during the past year can have a significant effect on the officer's ability to perform his assigned task effectively. Additional study is needed to address specific time periods and the effects of the number of accidents investigated in those time periods on retention.

Education Beyond High School

This researcher addressed education and its effect on retention of cognitive knowledge gained in the AI-1 training

program. College education in the form of an associate degree obtained from a two-year institution was positively related to retention of AI-1 cognitive knowledge, of the officers who participated in this evaluation. Officers who had a four-year degree or more had lower scores than those with associate degree's. Several two-year institutions in Michigan offer an associate degree in law enforcement. Some of the two-year institutions offer college classes that are oriented toward the skills and knowledge needed to perform traffic related duties effectively. Three Michigan colleges offer a two-year law enforcement associate degree in conjunction with the basic police academy. It would be interesting to determine whether the police officers who scored higher on the performance retest had such a degree.

Other Traffic Related Training

Other traffic-related training programs are available to Michigan police officers, such as radar, alcohol detection, legal updates, court testimony, selective enforcement, and other levels of accident investigation. Other training might have improved the scores of the officers who took the performance retest. Future researchers could determine whether additional training affects an officer's ability to investigate traffic accidents. Evaluations of this type could be employed to identify the variables that are positively related to retention of cognitive knowledge gained in the other training programs listed above.

Police Officer Age

This research included officers in the age range of 24 to 43 years. Information from the literature review suggested that age does not become a factor in cognitive retention until later years. Future researchers could address the issue of longevity and its effect on an accident investigator's knowledge. The issue of how long an individual has been performing a specific skill and its relationship to retention has not been addressed. An evaluation addressing this issue could help determine whether police officers should specialize in certain functions such as accident investigation.

APPENDICES

APPENDIX A

SUMMARY OF TEST DEVELOPMENT

Summary of Test Development

The purpose of developing the Traffic Accident Investigation tests was to evaluate the effectiveness of the Michigan State University Highway Traffic Safety Center's AI-1 course formats. Emphasis was placed on developing and using test items that were highly relevant to the objectives of instruction. The validity of item content was ascertained by the judges. Although such matters as the shape of score distributions, the indices of difficulty and discrimination, and the reliability coefficients were of secondary importance, these data were presented on each content area for both the pre-test and the post-test.

The following observations can be made:

1. The pre-test scores for the total test and each content area were normally distributed.

2. The post-test distributions of four content areas deviated from normaility, showing the students' mastery of course content. One content area of five was normally distributed. However, the post-test total score distribution retained normality.

3. The reliability coefficients on the post test were higher than the corresponding coefficients on the pre-test. The pre-test scores included a large guessing factor. The actual reliability coefficients of the post-test might be higher than those reported, since mastery of items leads to an underestimate of test reliability. Ebel stated that if a test

includes many items on whcih the average score is near 100%, the underestimate of reliability could be quite large. [59]

The data presented support the adequacy of the tests for the purpose they served.

---

[59]Ibid., p. 415

APPENDIX B

CURRICULUM OUTLINE

Unit 1.1

Highway Traffic Safety Program
Civil & Environmental Engineering
Michigan State University

Curriculum Outline

1. Introduction/Overview

   1.1 Introduction & Overview
   1.2 Student Assessment (Pre-Test)
   1.3 Expected Student Competency Levels

2. Measuring and Recording

   2.1 Field Sketching
   2.2 Field Measurements
   2.3 Accident Photography
   2.4 Field Exercise #1

3. Elements of Traffic Accidents

   3.1 Multiple Causation Theory
   3.2 Elements of Traffic Accidents

4. Speed Determination

   4.1 Symbols/Abbreviations, Speed & Velocity
   4.2 Determining Drag Factors
   4.3 Determining Speed from Skidmarks
   4.4 Determining Yaw/Sideslip and Critical-Curve Speeds
   4.5 Fall, Flip-Vault and Combined Speeds
   4.6 Field Exercise #2

5. Roadway Evaluation

   5.1 Roadway Evaluation Introduction
   5.2 Final Positions
   5.3 Tiremarks
   5.4 Metal Scars
   5.5 Debris
   5.6 Fixed Objects
   5.7 Field Exercise #3

6. Vehicle Evaluation

   6.1 Types of Vehicle Damage
   6.2 Thrust and Collapse
   6.3 Ground Contact
   6.4 Recording Damage to Vehicles
   6.5 Field Exercise #4

7. Legal

   7.1 Duties Required by Statute
   7.2 Authority to Gather Accident Information
   7.3 Enforcement Authority at Accident Scenes

8. Course Review

   8.1 Review of Course Content

9. Course and Student Evaluation

   9.1 Student Evaluation (Post-Test)
   9.2 Course Evaluation by Students

APPENDIX C

OFFICER INFORMATION SHEET

Name_____ Social Security No._____
(Last) (First) (M.I.)
Birthdate _____ Age _____

AI-1 Course Location_____ AI-1 Course Dates_____

AI-1 Course Score -- PRETEST_____ POST TEST_____

Employing Agency_____ Phone ( )_____

Agency Address _____
(street) (city) (zip)
Total number of Police personnel (sworn only)_____

Rank_____ Education HIGH SCHOOL 1 2 3 4 COLLEGE 1 2 3 4

Years of Police Service_____ Years assigned specifically to traffic_____
Approximate number of traffic accidents investigated by you in last months:

	Fatal	Personal Injury	Property Damage
6 months	_____	_____	_____
12 months	_____	_____	_____

Accident Investigation courses complete beyond AI-1 - circle the ones you have completed -- AI 2 3 4 5 6 7 8 9 10

Other traffic related training: Where, When, Length, and Basic Content
Content Where When Length

Assigned to:
___Patrol Division
___Traffic Division
___Training Division
___other: _____
_____

Function:
___General Patrol
___Traffic Enforcement
___Training
___other: _____
_____

Duties:
___Administrative
___Supervisory
___"Line" operations
___other: _____
_____

Please answer the following question on the 1 to 5 scale (1 = disagree and 5 = agree). Since completion of AI-1. Circle one number for each question.

1. I still maintain the knowledge and skills gained in AI-1. 1 2 3 4 5

2. My department encourages and allows me to use the information obtained in AI-1. 1 2 3 4 5

3. The quality of my accident investigation has improved. 1 2 3 4 5

4. I frequently refer back to my AI-1 training material in order to complete the investigation. 1 2 3 4 5

Use the following space (including the back) to describe: 1) How AI-1 can be improved 2) How or if AI-1 training has benefited you and your department and 3) If you currently do not have a good grasp on AI-1 content and skill - why not.

APPENDIX D

AI-1 TEST - PART 1

DO NOT WRITE ON THIS TEST BOOKLET

AI-I
Test

Booklet # ____

Part 1

Questions 1 thru 15 will consist of you watching slides projected on the screen. The instructor will ask you a question about each of the slides as they are projected. Choose your answer to the question from the answers given below. Mark your answer on the answer sheet provided. There is only one correct answer to each question. Questions 1 thru 15 are worth 3 points each.

1. Answers:

   A. Acceleration
   B. Braking
   C. Not Sure

2. Answers:

   A. Triangulation
   B. Coordinate
   C. Offset
   D. Not Sure

3. Answers:

   A. Gap skid
   B. Skip skid
   C. Tire mark
   D. Not Sure

4. Answers:

   A. Rub off
   B. Imprint
   C. Superimposed contact damage
   D. Not Sure

5. Answers:

   A. Skidmark
   B. Scuffmark
   C. Tireprint
   D. Not Sure

6. Answers:

   A. Coordinate
   B. Offset
   C. Triangulation
   D. Not Sure

7. Answers:

   A. Yawmarks
   B. Tireprints
   C. Skidmarks
   D. Not Sure

8. Answers:

   A. Tire grinding
   B. Pavement grinding
   C. Scratch
   D. Not Sure

9. Answers:

   A. Acceleration
   B. Braking
   C. Not Sure

10. Answers:

   A. Furrow
   B. Rut
   C. Tireprint
   D. Not Sure

11. Answers:

   A. Contact damage only
   B. Induced damage only
   C. Both contact and induced damage
   D. Not Sure

12. Answers:

   A. Contact damage only
   B. Induced damage only
   C. Both contact and induced damage
   D. Not Sure

13. Answers:

   A. Controlled
   B. Uncontrolled
   C. Not Sure

14. Answers:

   A. Straight
   B. Curved
   C. Overlapping
   D. Not Sure

15. Answers:

   A. Rotated to its left (clockwise)
   B. Rotated to its right (counter-clockwise)
   C. No rotation
   D. Not Sure

Page 3 (Questions 16 thru 60 are worth 1 point each)

16. When one vehicle crosses over onto the wrong side of the road and occupies the path assigned to another vehicle, this is referred to as:

A. Encroachment
B. Maximum engagement
C. First harmful event
D. Disengagement
E. Not Sure

17. Which of the following correctly lists the five types of metal scars that can be found on the roadway at accident scenes?

A. Scratch, scrape, chip. imprint, furrow
B. Scratch, scrape, chip, chop, groove
C. Scratch, scrape. furrow, rip, imprint
D. Scratch. imprint, gouge, rip, furrow
E. Not Sure

18. How should a measurement of 5 feet and 6 inches be written on a field sketch, as recommended in the text?

A. 5'6"
B. 5 5'
C. $5\frac{6}{}$
D. 66"
E. Not Sure

19. All but one of the following should appear on every field sketch. Identify the exception.

A. Date of accident
B. Scale of sketch
C. Direction north lies by the compass
D. Name of person making sketch
E. Not Sure

20. Compute the minimum initial speed of a vehicle that laid down 90 feet of locked wheel skidmarks on a pavement surface with a coefficient of friction of .72

A. 37 mph
B. 40 mph
C. 44 mph
D. 54 mph
E. Not Sure

21. Measurement(s) to be taken first at the scene of an accident should be:

A. Marks or residues of a temporary nature
B. Permanent gouges on the pavement
C. The longest distances that have to be measured
D. The width of the streets involved
E. Not Sure

22. When calculating the speed of a vehicle that slid on a road with a 6% downgrade:

A. .06 is added to the coefficient of friction
B. The 6% is not considered, as that variable is already compensated for in the basic speed formula
C. .06 is subtracted from the measured skid distance
D. The 6% is not considered if, to determine the drag factor, the test skid is made down the same grade the accident vehicle slid on
E. Not Sure

23. The "shadow" of a skidmark is:

A. The part of a skidmark in which a locked wheel loses contact with the ground when it bounces or skips
B. The indistinct part of a skidmark left before a tire becomes hot enough to smear
C. The distance through which brakes are slowing the vehicle before they are applied hard enough to lock the wheels
D. The superimposing of one skidmark on another
E. Not Sure

24. When skidmarks left by a car are curved:

A. Each should be measured in a straight line from one end to another
B. Each should be measured along the curve
C. The distance should be measured from the center point of the car where it began to slide, to the center point where it stopped sliding
D. The longest skidmark should be measured along the curve
E. Not Sure

25. In estimating speed from skidmarks, it is important to remember that you are determining the:

A. Exact speed of the vehicle prior to the collision
B. Maximum speed of the vehicle prior to the collision
C. Minimum speed the vehicle would have to be travelling to lay down the skidmarks
D. Actual crash speed
E. Not Sure

26. The coefficient of friction is:

A. The ratio of force necessary to slide an object at uniform speed on a surface, to the pressure of the object against that surface
B. The amount of friction generated between the brake shoes and the brake drums
C. The amount of grade, plus or minus
D. The amount of buckling that occurs when objects collide
E. Not Sure

27. "Superelevation" is:

A. A raised stretch of road over a railroad track
B. Number of feet a road rises for each 100 level feet along the road
C. A measure of the sharpness of a curve
D. Slope measured across the road on a curve
E. Not Sure

28. Photographs are admissible in evidence only when:

A. The photographer is first called to testify
B. They are not gruesome or bloody
C. They are material and relevant to the issues in the case and a proper foundation is laid for their introduction
D. No one objects at trial to their introduction into evidence
E. Not Sure

29. That event in the accident which stabilizes the accident situation is:

A. First harmful event
B. Initial contact
C. Disengagement
D. Stopping
E. Not Sure

30. During your investigation of an accident, you learn that an unidentified vehicle forced Vehicle #1 off the road. There was no collision between the unidentified vehicle and Vehicle #1. The unidentified vehicle is properly referred to as:

A. A hit and run vehicle
B. A disengaged traffic unit
C. An evasive action unit
D. A non-contact unit
E. Not Sure

31. Skidmarks at the scene of an accident:

A. Can only be used if the vehicle that slid is found at rest on those skidmarks
B. Can be used to show the physical condition of the driver
C. Are useless unless there are four identifiable marks
D. Can be useful in determining initial positions of vehicles
E. Not Sure

32. A vehicle with a speed of 45 mph is travelling at a speed of _____ feet per second (fps).

A. 38 fps
B. 45 fps
C. 54 fps
D. 66 fps
E. Not Sure

33. An accident-involved driver's decision to operate his vehicle while under the influence of alcoholic beverages, is a _____ contributing factor to that collision.

A. Condition
B. Operational
C. Physical
D. Mental
E. Not Sure

34. A velocity above which a particular highway curve cannot be negotiated by a motor vehicle without yawing, is called:

A. Traction instability
B. Grade and/or slope
C. Crucial event speed
D. Critical speed
E. Not Sure

35. A dent pressed into vehicle body parts by some stronger object which clearly shows it shape, is called:

A. Obscured contact motion
B. Collapse
C. Imprint
D. Rub-off
E. Not Sure

36. When the accident scene is blanketed with heavy snow, the measuring method you are most likely to use is the _____ method.

A. Triangulation
B. Coordinate
C. Offset
D. Engineering
E. Not Sure

For the following TRUE-FALSE QUESTIONS, mark answer "A" on the answer sheet for "True", answer "B" for "False" and answer "C" for "Not Sure."

37. The purpose of making urgent measurements is simply to locate temporary and short-lived positions with respect to landmarks which are permanent.

38. When using the triangulation method, you should measure two triangles for every spot you want to locate.

39. When using triangulation to locate points on an accident sketch, the investigator should select permanent points for two corners and a temporary object for the third corner.

40. In measuring the total length of skidmarks, for determining minimum initial speed, you should include any and all gaps as part of the overall skidmarks.

41. The drag factor/coefficient of friction of a road surface can best be established by consulting the table of drag factors in J.S. Baker's text, "Traffic Accident Investigation Manual."

42. The essential difference between tireprints and skidmarks is one of rolling as compared to sliding.

43. The speed computed from accident skidmarks does not represent all of the actual speed of the vehicle just before the brakes were applied.

44. Unless there are four distinct marks, skidmarks are of no value as evidence.

45. A vehicle travelling at 65 mph on a surface with a drag factor of .55 will have a braking distance of about 210 feet.

46. A car and driver together weigh 3,000 lbs and skids to a halt in 30 feet from a known speed. If six additional passengers weighing a total of 1,000 lbs are added to the car and all other conditions remain the same, the test skid would be approximately 40 feet long.

47. Using a drag factor of .75 and a speed of 30 mph, the skidding distance of a vehicle would be approximately 58 feet.

48. Grass pinched between a tire and wheel rim would indicate that the vehicle moved violently sideways.

49. Collapsed parts of vehicles involved in accidents can indicate the direction and, to a degree, the amount of force which did the damage.

50. Reconstruction of an accident is nearly always based upon measurements made at the accident scene during the initial investigation.

51. Contact damage usually makes spider-web appearing or circular cracks in windshields.

52. The accident investigator must know the reaction time of the driver involved, to accurately estimate speed from skidmarks.

53. Superelevation is the rise or fall across a roadway on a curve.

54. Skidmarks begin just as soon as the brakes on a car are applied.

55. Physical facts at the scene cannot lie, but their significance may be frequently overlooked or misinterpreted.

56. In determining the radius of a curve, the entire length of the curve must be measured.

57. An accident begins to happen at the instant of impact or upset.

58. If a vehicle had the right front wheel lock up while the others remained free-rolling, the vehicle would turn clockwise.

59. If the two rear wheels locked while the two front wheels remained free-rolling, the vehicle would slide straight ahead.

60. A field sketch is drawn to scale while a map is not to scale.

APPENDIX E

AI-1 TEST - PART 2

Highway Traffic Safety Programs
Civil & Environmental Engineering
Michigan State University

AI-I
Test

PRINT Your Name Clearly _____

Part 2

Score _____

SPEED CALCULATION PROBLEMS (5 points for each question)

Do your work on this page to answer these two problems. Use the reverse side for your calculations if necessary. Show your work as completely as possible. Partial credit may be given even if you do not arrive at the correct answer. Round your answer down to the nearest whole mph.

Problem A

The following skidmarks were straight and made on a level asphalt surface.

Accident Vehicle Skidmarks:

LF = $196\frac{4}{}$ RF = $196\frac{8}{}$

LR = $196\frac{11}{}$ RR = $197\frac{2}{}$

Test Skid Vehicle Skidmarks:

LF = $39\frac{11}{}$ RF = $39\frac{10}{}$

LR = $40\frac{6}{}$ RR = $40\frac{4}{}$

Test Skid Vehicle Speed = 30

Question: What was the vehicle's minimum initial speed? _____ mph

Not Sure _____

Problem B

A vehicle failed to negotiate a curve, leaving yawmarks on the road. You determine that the yawmarks have a middle ordinate of 11 inches when you use a 60 ft. chord. You also note that the curve superelevation is +.02.

Test skids you conducted at 30 mph on a level stretch of roadway as close to the accident site as possible resulted in the following:

	Left Front	Right Front	Left Rear	Right Rear	Average
Test #1	$46\frac{0}{}$	$47\frac{0}{}$	$43\frac{0}{}$	$44\frac{0}{}$	_____
Test #2	$45\frac{0}{}$	$44\frac{0}{}$	$41\frac{0}{}$	$42\frac{0}{}$	_____

Question: What was the vehicle's sideslip (yaw) speed? _____ mph

Not Sure _____

BIBLIOGRAPHY

BIBLIOGRAPHY

Anderson, R. C., and Biddle, W.B. "On Asking People Questions About What They Are Reading." Psychology of Learning and Motivation. Edited by G. Bower, New York: Academic Press, 1975.

Andre, T., and Thieman, A. "Learning Concepts by Reading." Contemporary Educational Psychology 13 (1988): 296-307.

Atkinson, R. C. and Shiffron, R. M. "Human Memory: A Proposed System and Its Control Process." In K. W. Spence and J. T. Spence (Eds.) The Psychology of Learning and Motivation (Vol. 2), New York: Academic Press, (1968): 314-315.

Ausubel, D. P. "Relationships Between Didactic and Experimental Learning." Paper prepared for the National Center for Research in Vocational Education Symposium on Learning-In-Work, Washington, D.C., October, 1980.

Ausubel, D. P. Educational Psychology: A Cognitive View. New York: Holt, Rinehart and Winston, 1968.

Bandura, A. Social Learning Theories. New York: General Learning Press, 1971.

Belbin, Eunice, and Downs, Sylvia. "Interference Effects From New Learning: Their Relevance to Design of Adult Training Programs.: Journal of Gerontology, 20, (1965): 154-159.

Bilodeay, E. A. and Levy, C. M. "Long-Term Memory as a Function of Retention Time and Other Conditions of Training and Recall." Psychology Review, 71, (1964): 24-41.

Blanton, B. Elgit. "Reception Learning and Advanced Organizers: Implications for Reading". In National Reading Conference. Edited by Frank Greene. Milwaukee: The National Reading Conference, (1972): 4-5.

Borg, Walter R. and Gall, Meredith D. Educational Research: An Introduction. New York: David McKay Company, Inc., 1974.

Bruner, J. S. "The coursed in Cognitive Growth." American Psychology, 10, (1964): 1-15.

Carrol, J. B. "The Model of School Learning: Process of an Idea." In C. W. Fisher & D.C. Berliner (Eds.) Perspective on Instructional Time. New York: Longman, (1985): 29-58.

Cheng, P.W. "Restructuring versus Automaticity: Alternative Accounts of Skill Acquisition. Psychology Review, 92, (1985): 214-223.

Cornwell, J. B. "Justify Your Training Efforts with on-the-Job Performance". Training, Vol. 17., No. 8 (August, 1980): 34-36.

Davey, B. "Cognitive Styles and Reading Achievement." Journal of Reading, Vol. 20, (1976): 113-120.

Ebbinghaus, H. Uber Das Gedachtnis. Leipzig: Dunker & Humbolt, 1885. Translated by H. Ruyer and C. E. Bussenius. New York: Columbia Teachers College, 1913.

Ebel, R. L. Essentials of Educational Measurement. Englewood Cliffs, N.J., 1972.

Flavel, L. J. "On Cognitive Development". Child Development, 53, (1982): 1-10.

Frankel, M. T. and Rollins, H. A. "Associative and Categorical Hypotheses of Organization in the Free Recall of Adults and Children." Journal of Experimental Child Psychology, 40, (1985): 304-318.

Gagne, E. D. "Long-Term Retention of Information Following Learning From Prose". Review of Educational Research, 48, (1978): 629-665.

Glasss, Gene V. and Hopkins, Kenneth D. Statistical Methods in Education and Psychology. Englewood Cliffs, NJ: Prentice Hall, 1984.

Glazer, Waldman and Cox, Hilda. "The Use of Similarity Judgments to Assess the Effectiveness of Instruction". Education, Vol 100, No. 4, (1980): 352-359.

Justice, Elaine M. and Weaver-McDougal, Rebecca G. "Adults' Knowledge About Memory: Awareness and Use of Memory Strategies Across Tasks". Journal of Educational Psychology, 81(2), (1986): 214-229.

Kirkpatrick, E. A. "An Experimental Study of Memory". Psychological Review, Vol. 1, (1894): 602-609.

Kirkpatrick, D. L. "Techniques for Evaluating the Effectiveness of Technical Training." Training and Development Journal, (June, 1971): 86.

LaPorte, R. E. and Voss, I. F. "Retention of Prose Materials as a Function of Post-Acquisition Testing". Journal of Educational Psychology, 67, (1975): 259-266.

Law, Alexander, and Bronson, William H. "The Evaluation Improvement Program". Evaluation Trainer's Guide. Princeton, NJ: Educational Testing Service, 1977.

McGeoch, J. A. "Forgetting and the Law of Disuse". Psychological Review, 39, (1932): 352-370.

McGeoch, J. A. and Irion A. L. The Psychology of Human Learning. New York: David McKay, 1952.

McLeod, Beverly, and McLaughlin, Barry. "Restructuring or Automaticity? Reading a Second Language". Language Learning, 33, 1 (March 1983): 135-158.

Mehrens, W. and Lehmann, I. Measurement and Evaluation in Education and Psychology. New York: Rinehart and Winston, Inc., 1986.

Michigan Department of State Police, Michigan Traffic Accident Facts. Col. R. T. Davis, Director, Lansing, Michigan, 1988, 5.

National Safety Council. Accident Facts, Chicago, Illinois, 1989, 5.

Page, Terry G. and Thomas, J. B.; with Marshall, R. International Dictionary of Education. London: Kegan, Paul: New York: Nicholas Publishing Co., (1977): 381.

Pressley, D. L., MacKinnon, G. E. and Waller, T. G. (Eds.). Metacognition, Cognition and Human Performance. New York: Academic Press, (1985): 111-153.

Sage, G. H. Introduction to Motor Behavior: A Neurospsychological Approach, 2nd ed. Menlo Park, California: Addison Wesley, 1977.

Scovel, T. "Questions Concerning the Application of Neurolinguistic Research to Second Language Learning/Teaching". TESOL Quarterly, 16, (1982): 323-332.

Singer, Robert N. Motor Learning and Human Performance, 3rd ed. New York: Macmillann, 1981.

Swierczek, Fredricks and Carmichael, Lynne. "The Quantity and Quality of Evaluating Training". Training and Development Quarterly, (January, 1985): 95-99.

Thesaurus of Psychology: Index Terms, 5th ed., American Psychological Association, 1988, Vol. 3.

Thorndike, E. L. The Psychology of Learning. New York: Teachers College, 1914.

Tolman, E. C. "Psychology: A study of A Science". In S. Koch (Ed.). New York: McGraw-Hill, 1959.

Tulving, E. and Watkin, J. J. "Continuity Between Recall and Recognition". American Journal of Psychology, 86, (1973): 739-748.

Underwood, B. J. and Postman, L. "Extraexperimental Sources Of Interference In Forgetting." Psychological Review, 67, (1960): 73-95.

Waters, H. S. "Memory Development in Adolescence: Relationship Between Metamemory, Strategy Use and Performance." Journal of Experimental Child Psychology, 33, (1982): 183-195.

Weisss, Thomas Michael; Hover, K. H.; and Mills, D. F. Psychological Foundations of Education. Dubuque, Iowa: Wm. C. Brown, 1963.