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ABSTRACT

The study compared the driving histories, for the first six months and first two years following licensing, of drivers who had received two types of driver training in high school in 1971. The subjects were 1644 drivers who had been trained on multi-vehicle ranges and 1759 who had received the traditional "30 and 6" training (30 hours of classroom instruction and 6 hours of behind-the-wheel instruction). It attempted to determine whether the differences in training brought about by the construction of range facilities in North Carolina has resulted in additional benefits in terms of accident savings or increased output of trained students. The study analyzed three major variables: (1) non-driving related (age, race, sex, I.Q., etc.), (2) accident involvement, and (3) violation histories, for the two groups. A categorical analysis of the data indicated no significant differences between the range group and the "30 and 6" group in terms of accident involvement but the traditional groups had somewhat fewer accidents and violations, although the difference was not significant. Inconclusive differences were noted when the results were analyzed by race and sex. A cost effectiveness analysis revealed that the cost per student was higher in the range program. The limitations and implications of the study are discussed. (Author/BP)

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- An Evaluation of North Carolina's Multi-Vehicle Range Program In Driver Education: A Comparison of Driving Histories of Range and Non-Range Students

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The UNC Highway Safety Research Center was created by an act of the 1965 North Carolina General Assembly. A three-point mandate issued by the Governor authorized HSRC to 1) evaluate the state's highway safety programs, 2) conduct research, and 3) instruct and train other working professionals in highway safety.

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ABSTRACT

Since 1969, the Department of Public Instruction has been in the process of expanding its driver education program. As part of this expansion, eighteen multi-vehicle range laboratories have been put into operation. This report deals with the evaluation of these driving ranges and their effectiveness as a tool in the driver education system. In this evaluation, the accident experience of two samples of students were compared -- those taking training on the range facilities and those receiving the standard "30 and 6" training course.

Categorical analysis of the data indicate no significant differences between the range group and the control group in terms of accident involvement. In examining the mean number of accidents and violations per student in various demographic subsets of the sample, any slight differences noted favored the control group -- i.e., the control subsets had fewer accidents and violations. There were, however, no clearcut significant differences in these accident and violation histories.

Thus, under the assumption of equal training effects, an attempt at cost effectiveness analysis was made. This analysis of the costs involved in the two types of training indicated that the cost per student is higher in the range program.

The authors have not been able to find a change in the driving behavior of range trained students, or a decrease in the cost per student. However, a few limitations with this study are noted:

1. The accident and violation histories were derived from the earliest range programs and might be out of date in terms of their instructional methods.

2. Socio-economic biases might have clouded the treatment groups.

3. Accidents and violations may not always be an appropriate measure of driver performance.

4. The cost analyses were based on limited and non-research oriented data.

In view of the limitations of the sample data, the authors advise the continuation of the program with recommendations for up-grading and strengthening the program by:

1. Increased use of the existing facilities.

2. Continued monitoring of the national changes in curricula.

3. Modification and innovation in the training procedures.

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I. INTRODUCTION

In North Carolina, driver education has traditionally been taught using a 30 and 6 format which is comprised of 30 hours of classroom instruction and six hours of "behind-the-wheel" instruction.

The Department of Public Instruction, the agency responsible for educating North Carolina's youth in safe driving practices, began in 1969 to expand its driver education program. This was done through the development of multi-vehicle range laboratories in various school districts across the state. An initial group of seven such facilities was constructed in 1969-70, and the program has continued to expand to the 18 facilities now operational.

Range training requires the construction of a multi-vehicle facility where several cars can be in motion at once. In North Carolina, most of these relatively small paved areas are approximately 400' by 200'. Maneuvers present on the ranges include: angle parking, parallel parking, backing, merge lane, figure 8, yield controlled intersection, traffic signal controlled intersection, stop controlled intersection, two way streets, one way streets, and curved streets. The range training differs from the "30 and 6" program in that in "30 and 6," all the behind-the-wheel instruction is given on rural and city streets.

The Department of Public Instruction and the Univeristy of North Carolina Highway Safety Research Center initiated a joint project in 1973 aimed at evaluating and upgrading the range-related driver education program. This effort included inventory of the existing programs, evaluation of the performance of students receiving the training, and development and evaluation of new teaching strategies which, if proved successful, might be utilized in the future. This report deals with efforts in the second basic area, that of performance evaluation. Specifically, the present study involves the comparative analysis of the driving records of students involved in initial range training and a control group of students involved in the more standard non-range training.

The study was conducted in an attempt to determine whether or not differences between the two types of training would be reflected in the accident and violation histories of the two groups. Because the construction of range facilities requires additional expenditures of funds, at least initially, it is important to ascertain whether these additional funds are resulting in discernable benefits to the state. Because it has been hypothesized that use of range facilities allows for more students to be taught per hour of instructor time, it could be argued that payoff is resulting from the increased output of trained drivers. For this reason, cost data for various range and non-range programs were also gathered. An attempt at cost-effectiveness analysis is included in this report.

It is also important to note that this is not an evaluation of driver education per se. Because all North Carolina drivers under 18 years of age must have passed a certified driver training course, no valid control groups exist for such a comparison. This study is, instead, an attempt to determine whether the differences in training brought about by construction of range facilities in North Carolina has resulted in additional benefits in terms of accident savings or increased output of trained students.

II. REVIEW OF THE LITERATURE

As was noted in the preceeding section, this study does not involve an evaluation of driver education per se. Many such studies have been conducted in the past, and most contained methodological problems which resulted in questionable conclusions. Illustrating these problems are two studies reviewed here.

Conger, et al. (1966) studied the accident and violation records of three groups of adolescent male drivers during their first four years of driving. Group 1 consisted of students electing and completing driver training; Group II consisted of students wishing to take driver education but unable to do so; and Group III consisted of students who did not wish to take driver education, and did not take it.

In an uncontrolled comparison of driving records, it was found that subjects in Group I scored significantly lower than those in Groups II and III on violations and "points." No significant differences were obtained for responsible accidents, although Group I again scored lowest. However, the analysis also revealed significant differences between the three groups on exposure (miles driven per year), socioeconomic status, and I.Q.

In a second analysis, the authors controlled for these other factors through an individual matching technique. When this was done, in contrast to the first analysis, significant differences in responsible accidents were noted, with Group I accumulating fewer accidents. The previously noted differences in violations and "points" disappeared.

Because of the "reversals" of violation and accident related results from one analysis to the other, the authors did not draw strong conclusions concerning the effectiveness of the training. They did note that these results indicated that other studies purporting to show differences (or no differences) in driver behavior between students who have and who have not had driver education may be influenced by factors other than the driver training experience itself.

McGuire and Kirsh (1969) reviewed the previous study and many others in a book concerned with the history, philosophy, and effectiveness of driver education as indicated in past studies using various research methodologies. In their review of past studies, two basic deficiencies were noted by the authors: (1) total lack of control for exposure, and (2) lack of control for correlated variables. In relation to the first deficiency, the major problem was the lack of recognition of the difference between the average miles driven per year between non-driver education and driver education students. The authors contend that data show driver education students drive far fewer average miles per year than do their non-driver education contemporaries. Therefore, any comparison of the absolute accident experiences of these two groups would tend to favor the driver education group, since exposure is correlated with accident experience.

In their discussion of factors which could lead to bias in driver education studies, the authors presented a list of 24 variables, other than training, which are significantly correlated with raw accident frequency. Fortunately, all variables need not be included in analyses due to high intercorrelations. However, the failure to control for these variables has led to erroneous conclusions.

Based on analyses of their own data, the authors tentatively concluded that high school driver education bears no causal relationship to either traffic violations or accident frequency. However, they also emphasized that the entire question should be subjected to more sophisticated experimental designs before a claim is made for a lack of relationship.

Because of the problems arising in such studies, the related lack of relationship between driver education and accidents, and the desire of driver education administrators to strengthen their programs, the more traditional "30 and 6" programs have been modified to include the use of driving ranges, simulators, and other tools. While very little evaluative work concerning use of ranges has been conducted, several studies concerning use of simulators are in the literature.

Eales (1961) reported on experiments, carried out in 1954 in New York, California, and Iowa which were aimed at determing the value of the Drivotrainer, a driving station mock-up with films. Results of all three of these studies showed that students who substituted time in the simulator for part of the time usually spent in actual driving:

1. Learned driving skills as well as students who spent the regularly allotted amount of time in the car.

2. Acquired better attitudes and understandings regarding safer driving.

3. Did so at a reduced cost.

From the research on the experiences of the California schools, Eales concluded that a simulator - car program allows the student to learn the basic skills of driving and also gives him a chance to experience a variety of emergency situations and defensive driving techniques. This program is also found to be less costly than the conventional program which uses only the car.

Koebler (1973) carried out an investigation to determine the effectiveness of "30 and 6" driver education and of simulator training and compared their effectiveness with the cost of providing these programs.

The author utilized data on students volunteering for a "30 and 6" program in 1966 and students volunteering for a simulator program (30 and 3 plus 12 hours of simulator work) in 1968-69. Each of these treatment groups was compared in a "matched pair" analysis with a control sample of non-volunteers from the same school matched on the basis of sex, "cultural heritage," father's occupation, and grade point average. Comparisons between the "30 and 6" and simulator programs were made on a non-matched basis, with, of course, the subjects being separated in time by two years.

A series of analyses concerning the "30 and 6" data resulted in conflicting results leading the author to conclude that ". . . the '30 and 6' data were sufficiently contaminated to preclude any valid conclusions" (p. 55). However, later in the paper, the authors stated the following conclusions:

1. The "30 and 6" program as taught in 1965-66 was not fulfilling its objectives of improving student ability to operate a car more safely. In fact, the students of the "30 and 6" driver education program were experiencing more convictions and accidents than those students who had not taken driver education.

2. Using conviction, accident, and severity of accident criteria, simulator training produced significantly better drivers than "30 and 6" driver education.

3. Cost per student for simulator training was less expensive than "30 and 6."

This investigation also made several recommendations including:

1. Upgrade the "30 and 6" program to an efficient level within a certain period of time or abandon the program.

2. Replace "30 and 6" with simulator training as quickly as is economically possible.

3. Place greater instructional emphasis on accident avoidance and damage reduction if an accident will occur.

In contrast to the findings of the effectiveness of simulation, as expressed in the above two studies, are findings expressed in the following papers.

Baron and Williges (1971) conducted a study to determine the differential effects of various amounts of film and simulator instruction on driving knowledge and performance. Forty-eight subjects were used, including eight licensed drivers with varying amounts of driving experience and forty students involved in a high school driver education course.

The results indicated that the amount rather than the type of pretraining (i.e., training before on-road driving) was the primary determiner of transfer to behind-the-wheel driving performance. The group which received six hours of pretraining showed significantly better driving performance than either the group which received three hours of pretraining or a control group which received no pretraining, regardless of whether the pretraining included films used in conjunction with simulators or films alone.

Also, it was found that a transition period is needed from the simulator to an actual car as revealed by the fact that the film-only groups surpassed the simulator groups on the procedure aspects of driving during the first testing session behind the wheel. When the overall driving performance was examined over the six testing sessions, the film-only and the simulator groups had the same driving performance.

The effects of previous experience upon simulator performance were examined by comparing the simulator performance of licensed drivers with that of simulator students. It was discovered that the licensed drivers exhibited poorer simulator performance than the students toward the end of the simulator sessions (possibly reflecting boredom resulting from lack of simulator realism). The licensed drivers did exhibit better performance than the students earlier in simulation on steering response.

An analysis of the effect of the type of pretraining on the components of driving performance during the first behind-the-wheel testing session revealed the film-only groups to be superior to the simulation groups on procedures.

Simulation was indicated as having resulted in a modest amount of transfer to behind-the-wheel driving. The authors recommended further research in order to isolate the factors contributing to transfer so that simulators may be used to the maximum of their potential.

In one of the most recent studies conducted, researchers at the University of California, Los Angeles (1973) evaluated driver education programs in the high schools of California. All students received 30 hours of classroom instruction. Comparisons were made between a group taking a standard "short" training program and a group taking an enriched "long" training program. The "short" program consisted of either six hours of on-road instruction or three hours of on-road plus at least three hours of additional simulation training. The "long" program consisted of these short programs plus four additional hours of behind-the-wheel on-road training. Comparisons were also made of the benefits and costs of driver education given in California high schools with that given by commercial schools.

The subjects (12,000) were selected at random and assigned to programs in which they were trained by either public high school or commercial school instructors in long or short training courses. The following background variables were measured on each student: age, sex, grade point average, citizenship grade, driver education grade, number of vehicles at home, exposure to vehicles, and exposure to bicycles.

Significant differences were revealed between males and females: males were younger, had lower grades, were less socialized, had more vehicles at home, and had more experience with both motor vehicles and bicycles.

Training variables measured included: (1) performance grade for driver training, (2) attitude grade for driver training, (3) student driving test, (4) instructor's evaluation of driving performance, (5) instructor's evaluation of student's confidence, (6) instructor's evaluation of student's skill, (7) student's self-confidence, (8) student's socialization, and (9) student's evaluation of training. It was found that males were superior in all variables except those measuring attitudes, and students trained in the short simulator programs were inferior to all other groups.

From the licensing variables that were used ((1) licensing delay, (2) number of attempts at the department of motor vehicles written test, (3) score on the department of motor vehicles road test, (4) percent licensed within 6 months, (5) percent licensed by the end of the study, and (6) percent of minor rejects), it was determined that there are no differences between the standard simulator and standard six hour in-car programs. Sex differences were present, with females requiring about five weeks longer, on the average, to become licensed and with fewer of them getting licensed.

As for accidents and violations, it was found that males have worse records in both categories. Thirty-five percent of males had some kind of citation during the first year of driving, whereas only twelve percent of females did. Males have many more speeding citations. Thirteen percent of males and seven percent of females were involved in accidents during the year. No consistent reliable differences in citations were found between long and short programs or between simulator and six-hour programs. Interestingly, there was no difference in accident rate between those trained in short and those trained in long programs. There was a suggestion that the six hour program students had a slightly worse accident record than the simulator students, but no strong conclusions could be drawn.

Concerning cost, the best estimate for training by high schools is about $70 per student as compared to about $50 per student for training by commercial schools. Simulator programs cost $18 more per student than do car-only programs, and long programs cost $36 more per student than the short program using public school instructors or $16 more per student using commercial instructors. Commercial training, short programs, and car-only training appear to be significantly less expensive for the same return.

Thus, review of the literature indicated contrasting findings both in studies of driver education, per se, and in studies of 'enhanced' driver education programs using simulation. The better controlled studies indicated no discernable differences between enhanced programs and standard '30 and 6' programs. The review of the literature did not provide any information on programs "enhanced" through use of a driving range facility. The present study will perhaps provide some information which will help to fill this gap.

III. METHODOLOGY

The basic method employed involved comparing the driving histories of students who were trained at the original seven range facilities in use in North Carolina in 1971 with the histories of a control group of students trained at the same time, but at locations where no ranges were available. The range trained students attended different schools from the non-range trained students. Based on information provided by the Department of Public Instruction, it was assumed that the locations of these initial seven ranges were established more or less at random across the state, and that there were no inherent biases such as community economic status which would affect the results.

The control students were chosen from a group of 17 schools across the state. These schools were randomly selected from a list of the 648 schools which had a ninth grade or above in 1971. The use of experimental and control subjects trained at the same time (and thus assumed to be driving at the same time) helps to overcome biases which might result from changes in basic accident patterns between different periods. For example, accident frequencies between time periods might change due to increased traffic or better roadways. Accident severities, as measured by injury, might change because of changes in vehicle crashworthiness over time.

For both the experimental (range) and control (non-range) groups, class rolls were obtained by the six driver education coordinators who served as data collectors, and a 50 percent sample of each was chosen. The coordinators determined whether the first or second student on the class roll would be the first subject by flipping a coin, and then information was collected on every other name.

For both groups, information collected included full name, address, birthdate, sex, race, and I.Q. and/or grade point average. The name, address, and birthdate allowed the matching of subjects with their subsequent driving records as tabulated by the N.C. Department of Motor Vehicles. The data captured from this driving history file included the original data of licensing for each subject and the subsequent two-year driving history. This two-year period was further subdivided into six-month intervals in order to provide information on the early driving experiences where the greatest differences due to training might be expected to show up.

Thus, for each subject the following variables were obtained for each six-month period:

Number of total accidents

Number of injury accidents (i.e., involved an accident where at least one occupant sustained some injury)

Number of non-injury accidents

Number of at-fault accidents (determined by a conviction appearing for a violation on the same date)

Number of total violations (e.g., speeding, DUI, reckless driving).

In addition, three other variables were calculated from the date of initial licensing for each subject -- (1) the subject's age at time of licensing, (2) the elapsed number of days to first accident, and (3) the elapsed number of days to first violation.

IV. ANALYSIS AND RESULTS

As indicated in the Introduction section, the first basic hypothesis to be tested involved whether or not range-trained driver education students are "better" drivers than a control group of students receiving the traditional "30 and 6" training. Here, "better" drivers will be defined as those having fewer accidents and violations. Three major analyses were conducted. The first involved comparisons of non-driving related variables (e.g., sex, race, I.Q.) between range and non-range groups. The other two major analyses concerned comparisons of accident and violation histories of the two groups.

Analysis of Variables Not Related to Driving

As indicated in Table 1 below, data were collected on 1644 students receiving range training and 1759 students receiving standard (non-range) training. Of these, 62.5 percent were subsequently linked with driving records on N.C. files.

It is noted that there are differences in the proportion of records linked in the various race-sex groups. Female proportions are lower in both races for both range and non-range subsets. Again, it is recalled that the original data were drawn from driver education class rolls. These lower proportions of records linked possibly reflect both the lower proportions of females obtaining driver licenses as noted in other studies (Jones, 1973) and the changes in names due to marriage for those receiving licenses.

As mentioned in the Methodology Section, it was assumed that the original seven range sites were chosen randomly across the state, and that because the control schools were also chosen at random, no inherent biases in such factors as economic status of the community existed between the two groups. To further examine whether the two samples were indeed similar, uni-variable comparisons of the sex, race, and I.Q. variables between range and non-range groups were made. Table 2 presents data on the proportions of students in each group by race and sex.

Table 1. Number of subjects on whom data were collected and proportion of group linked with subsequent driving history.

Race	Sex	Range: Linked with Driving Record	Range: Not Matched	Range: Total	Non-Range: Linked with Driving Record	Non-Range: Not Matched	Non-Range: Total
White	Male	492 (76.6)	150 (23.4)	642	424 (68.9)	191 (31.1)	615
White	Female	407 (68.8)	185 (31.2)	592	366 (62.9)	216 (37.1)	582
Non-White	Male	86 (57.3)	64 (42.7)	150	157 (54.7)	130 (45.3)	287
Non-White	Female	44 (43.1)	58 (56.9)	102	126 (46.5)	145 (53.5)	271
Not Stated	Male	16 (21.1)	60 (78.9)	76	1 (33.3)	2 (66.7)	3
Not Stated	Female	8 (9.8)	74 (90.2)	82	1 (100.0)	0 (0.0)	1
		1053 (64.0)	591 (36.0)	1644	1075 (61.1)	684 (38.9)	1759
	Male	594 (68.4)	274 (31.6)	868	582 (64.3)	323 (35.7)	905
	Female	459 (59.1)	317 (40.9)	776	493 (57.7)	361 (42.3)	854
	White	899 (72.8)	335 (27.2)	1234	790 (66.0)	407 (34.0)	1197
	Non-White	130 (51.6)	122 (48.4)	252	283 (50.7)	275 (49.3)	558

Table 2. Frequency and proportion of total students in range and non-range groups by race and sex.

		Range	Non-Range
White	Male	642 (43.2%)	615 (35.0%)
White	Female	592 (39.8%)	582 (33.3%)
Non-white	Male	150 (10.1%)	287 (16.4%)
Non-white	Female	102 (6.9%)	271 (15.4%)
*Total		1486 (100.0%)	1755 (100.1%)
	Male	792 (53.3%)	902 (51.4%)
	Female	694 (46.7%)	853 (48.6%)
	*Total	1486 (100.0%)	1755 (100.0%)
White		1234 (83.0%)	1197 (68.2%)
Non-white		252 (17.0%)	558 (31.8%)
*Total		1436 (100.0%)	1755 (100.0%)

Note: *Because students with incomplete data (e.g., unstated race) are deleted from this table, totals are different from those of Table 1.*

As can be seen, data for the total (linked plus unlinked) group of students reflect race differences between range and non-range groups. No major differences are observed in the proportions of males and females. However, it appears that the range group has a higher proportion of whites than the non-range group (in both sex categories). These differences could reflect race variations between schools in the two groups and/or differences due to data reporting variations between the samples. Table 1 indicates that while only 0.2 percent of the non-range group had unreported race, 9.6 percent of the range group had no race data reported.

Of more importance to subsequent analysis, are the data for the range and non-range subjects who were linked with their driving records. Table 3 presents the race/sex breakdowns for these linked students.

Table 3. Frequency and proportion of linked students in range and non-range groups by race and sex.

		Range	Non-range
White	Male	492 (47.7%)	424 (39.5%)
White	Female	407 (39.6%)	366 (34.1%)
Non-white	Male	86 (8.4%)	157 (14.6%)
Non-white	Female	44 (4.3%)	126 (11.7%)
Total		1092 (100.0%)	1073 (99.9%)

Again, there are differences in the proportion of subjects in the two samples who fall into each race/sex category. Because of this difference in Tables 2 and 3, and because past research has shown sex, and sometimes race, to be important predictors of accidents, all subsequent comparisons of range and non-range samples will control for these two variables.

Because of the finding of Conger, et al. (1966). I.Q. information was also collected whenever possible. Only 81.0 percent of the linked subjects appearing in Table 3 had usable I.Q. information because of restrictions on such information in some school units. There were differences in the proportions of subjects with valid I.Q. data between the various groups, with proportions varying from 40.0 percent for the non-white females given range training to 96.2 percent of the white females in the non-range group. Overall, the non-range sample had a higher proportion of valid I.Q. information in each subcategory.

In order to gain further insight into the question of differences between samples, the overall mean I.Q.'s for the range and non-range samples were compared. The data indicated a mean I.Q. of 102.3 for the range group and a mean of 99.0 for the non-range, a small but statistically significant difference ($p < .005$, t-test). However, because these differences could be a result of the differential race/sex breakdown in the two samples, individual mean I.Q.'s were compared for each race/sex category. The results are as follows:

Table 4. Mean I.Q. for each race/sex category for range and non-range samples.

		Range		Non-Range	
		$\bar{x}$	n	$\bar{x}$	n
White	Male	101.93	384	102.56	396
White	Female	105.40	314	103.84	352
Non-white	Male	84.88	43	86.28	139
Non-white	Female	93.06	18	86.53	107

The means in each group were compared using the student's t statistic. The results of the four comparisons indicated no significant differences in mean I.Q.'s within any group at the $p = .10$ level. Because of differences between groups, these results again indicate the need for control of race/sex variables in subsequent driver record analysis.

Analysis of Driving Records.

The main hypothesis under study concerns whether or not range-trained students are "better" drivers than the corresponding control group as measured by accident and violation entries on the driving records. It is important to note that raw frequencies of accidents and violations are the variables under study -- not accident rates on, say, a mileage basis. Because no meaningful exposure data could be collected in this retrospective study, the only available measure of exposure is "time after licensing." Thus, in order for the following comparisons to be valid, the assumption is made that the range and non-range groups accumulated approximately the same amount and type of exposure units (e.g., mileage) within the given time periods. As noted by McGuire and Kirsh (1969), problems have been encountered in previous studies of the effectiveness of driver education due to differences in exposure for the groups compared. While some difference between groups in the present study might well exist, the possibility of this happening is felt lessened by the training program and study design. That is, all students in both groups have "volunteered" for the driver education training. Volunteers and non-volunteers are not being compared. For the range group, all driver education students in a given school class using the range were given range training. The special training was not given only to those who volunteered for it. Therefore, theoretically, the control group is composed of subjects "volunteering" for driver education who are all given standard training. In a like manner, the treatment group is composed of subjects "volunteering" for driver education who are all given range training. The schools using the range are assumed to be similar to the control schools because of the presumed random location and the random choice of control schools. Under these conditions, it might also be assumed that the samples of students, as groups, will accumulate similar exposure units.

The first series of analyses conducted involved comparisons of the proportions of accident-involved drivers in the treated and control groups. That is, the data for each sample were divided into two subsets -- drivers who had experienced one or more accidents in a given time period and those who had experienced no accidents in the given period. The time periods in question were (1) the first six months after initial licensing and (2) the first two years after licensing.

In both cases, the statistical analysis employed involved fitting linear models to the proportion of accident involved drivers. The procedure used, the CATLIN computer package, is documented by Grizzle et al. (1969). The thrust of the general approach presented incorporates "conversion" of categorical data response frequencies (e.g., race, sex) into a series of functions which have calculable variance-covariance matrices under large sample theory. These functions ($\underline{F}$) then become dependent variables in the linear model format

$$\underline{F} = \underline{XB}.$$

This parallels the more familiar linear model format

$$\underline{Y} = \underline{XB}$$

or

$$\hat{y} = u + B_1x_1 + B_2x_2 + \ldots$$

Tests on the above model and on relevant hypotheses concerning the model are then conducted using weighted regression analysis procedures.

The series of analyses on the current data involved as the dependent or predicted variable both the proportion of drivers involved in any accident (total accidents) and the proportion involved in "at fault" accidents for the two-year period and the first six-month period. Since sex is known to be related to numbers or proportion of accidents, and since race has been shown in previous studies to be important in some contexts, both of these factors were included with the range/non-range variables as independent variables in each of the models examined. In addition, where adequate sample sizes existed, an I.Q. variable consisting of grouped I.Q. data (i.e., I.Q. $\leq$ 100 vs I.Q. $\geq$ 101) was included. A large series of such linear models was examined, ranging from simple models with only main effects to more complex models with various interactions included. The results of analyses presented below concern the models in each group which appear to be most efficient (in terms of significant variables) and provide the best fit of the data.

Models involving all accidents in two-year period.

This first series of models examined was designed to predict the proportion of drivers involved in one or more accidents during the first two years after licensing.

Models including I.Q. variables.

A series of models which included the driver training, race, sex, and I.Q. effects and various interactions was examined. As noted earlier, the I.Q. data were categorized into groups with I.Q.'s $\leq$ 100 and I.Q.'s $\geq$ 101. The final model indicating best fit of the data included five non-mean effects, none of which is considered a main effect. Information on the model is presented in the following table.

Table 5. Final model for proportion of drivers involved in one or more accidents in two years following licensing.

Variable	Coefficient	d.f.	χ^2	p
Sex within range sample	.1324	1	22.14	<.001
Race within non-range sample	.1026	1	11.30	<.001
Non-range, white males and females, high I.Q.	-.1340	1	14.68	<.001
Non-range, white males, high I.Q.	.4200	1	69.42	<.001
Non-range, non-white females, low I.Q.	-.0880	1	6.69	.000
Error		10	6.61	.7615

Interpretation of this information is less simple than in other analyses. The data analyses indicate that the proportion of accident-involved males of both I.Q. levels is significantly higher than the comparable proportion of females in the range sample. In the non-range sample, the proportion of involved whites is higher than the proportion of involved non-whites, a "main" race effect within the non-range sample. In addition to this race effect, the non-range data also indicate significant interactive effects in that the white male and female groups with high I.Q.'s have lower proportions of involved drivers than is expected from the race effect. In like fashion, the non-white females with low I.Q.'s also have a <u>lower</u> proportion of accident involved drivers. As can be seen, these results are somewhat confusing, with I.Q. having no significant main effect but having contrasting interactive effects.

Because these differences could result from small sample sizes in the non-white subsets, a series of further models was analyzed in which four levels of I.Q. were used for white subjects only. The four levels under study are < 90, 90-100, 100-110, > 110.

Models involving main effects for driver training, sex, I.Q. and all interactions involving I.Q. were examined. The best fitting model involved only sex as a main effect. Neither the main effect nor any interaction involving I.Q. was a significant predictor variable.

Models without I.Q. variables.

Because I.Q. did not prove to be a significant variable and because of the loss of data due to non-reporting of I.Q. in the range sample, a series of analyses was run on the proportion of drivers involved in all accidents over the two-year period which included all data shown in Table 3. Here, driver training, sex, and race variables, and their interaction were included as the independent variables. After both full and reduced models were examined, the final model yielding the "best" fit of the data involved the main effects associated with race and sex and an interactive effect identifying the non-white male drivers in the range and non-range group. Table 6 presents information on the model.

Table 6. Final model for drivers involved in one or more accidents in two years following licensing.

Variable	Coefficient	d.f.	χ^2	p
Race	.0372	1	13.15	<.001
Sex	.0678	1	56.89	<.001
Non-white, male range vs non-range	-.0622	1	4.90	.026
Error		4	1.85	.763

It is noted that the fit of this model is quite good as is indicated by the small χ^2 and large p-value for the error term. (A small p-value for error, e.g., $p < .05$, would indicate significant lack of fit in the model.) Because the race variable was coded 1 for whites and -1 for non-whites, the positive coefficient indicates that the non-white groups have a significantly lower proportion of accident-involved drivers than the white groups. The

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second significant main effect, the sex effect, indicates that the proportion of accident-involved males is significantly higher than the proportion of females. The interactive effect indicates that the proportion of accident-involved non-white males in the range group was significantly higher than the proportion in the non-range sample.

Models involving at-fault accidents in two-year period.

The second series of models was used to predict the proportion of drivers involved in one more more at-fault accidents. Again two series of analyses were carried out -- the first involving I.Q. (2 levels) and the second involving only driver training, race, sex, and various interactions.

Models including I.Q. variables.

After a series of models predicting the proportion of drivers involved in at-fault accidents were examined, the final most efficient model was as follows.

Table 7. Final model for proportion of drivers involved in at-fault accidents in two years following licensing.

Variable	Coefficient	d.f.	χ^2	p
Race	.0213	1	25.18	<.001
Sex	.0343	1	27.18	<.001
I.Q.	.0155	1	7.76	.005
Range non-white males	-.0650	1	3.97	.046
Error		11	3.70	.9779

The model indicates a significant race effect, with the proportion of accident-involved white drivers higher than the proportion of non-white drivers; a significant sex effect, with the male proportion higher than the female; and a significant I.Q. effect, with the proportion of accident-involved drivers with low I.Q.'s being higher than the proportion with high I.Q.'s. In addition, one significant interactive effect was observed where the proportion of accident-involved non-white males in the range group was higher than would be expected from the race and sex effects alone. The fact that the I.Q. main effect was significant in this data set where it had not been before indicates that all accidents and at-fault accidents are different criteria and that the small sample sizes available on the I.Q. variable may have influenced the results. For this reason, and in order to parallel earlier analyses of total accidents, the I.Q. variable was eliminated from the next series of models.

Models without I.Q. variables.

After a series of models was examined, the data indicated a final model as shown below.

Table 8. Final model for proportion of drivers involved in at-fault accidents in two years following licensing.

Variable	Coefficient	d.f.	χ^2	p
Sex	.0331	1	29.27	<.001
Range, non-white male vs non-white female	.0299	1	2.17	.141
Error		5	3.33	.649

Just as in the previous models, the sex variable is again highly significant, with the females again better. The only other marginally significant effect is race/sex interaction in the range sample where non-white males have higher proportions of involved drivers than do non-white females. Interestingly, a model involving the sex effect alone would have had a p-value for error of 0.4813.

Models involving total accidents in first six months after licensing.

Because of small sample sizes in the data when classified by I.Q., models for both the proportion of drivers involved in any accident and in at-fault accidents excluded this as an independent variable. Thus, full models examined again included driver training, race, sex, and their interactions. As noted previously, the first six-month time period was chosen for analysis since previous research (Jones, 1973) has indicated that training effects might be best reflected by accidents early in one's driving history, before experience becomes the dominant variable.

For the data involving all accidents during this first six months after licensing, the final "best" model again included the highly significant main effect due to sex and a marginally significant interaction within the non-white range subset.

Table 9. Final model for proportion of drivers involved in any accident during the first six months after licensing.

Variable	Coefficient	d.f.	X^2	p
Sex	.0269	1	18.68	<.001
Range, non-white male vs non-white female	-.0338	1	2.78	.095
Error		5	3.28	.658

The similarity between this model and that involving two-year at-fault accidents is noted. Again, under the design matrix coding used, these results indicate that the proportion of accident-involved females is significantly lower than the proportion of males. The significant interaction effect is interpreted as indicating that the difference between the proportions of accident-involved males and females in the non-white range group is even greater than is explained by sex alone.

Models involving at-fault accidents during the first six months after licensing.

The final series of models examined attempted to predict the proportion of drivers involved in at-fault accidents during the initial six months of driving. The final model, presented below, involved two interactions and, as usual, a highly significant sex effect.

Table 10. Final model for proportion of drivers involved in at-fault accidents during the first six months following licensing.

Variable	Coefficient	d.f.	χ^2	p
Sex	.0221	1	40.30	<.001
Driver training sex	.0090	1	10.74	.001
Range white males, vs white females	-.0138	1	6.37	.012
Error		4	0.81	.938

These results indicate that the proportion of accidents involving females was significantly lower than the proportion for males, that the differences between sex were greater for the range subset than the non-range subset, and that the differences between white males and females receiving range training were larger than could be explained by either of the first two effects.

Summary of analyses involving categorical models.

Regression models were examined in which categorical data on driver training, race, sex, I.Q. and various interactions were used to predict both total accidents and at-fault accidents over the two-year period following initial licensing and over the first six months following licensing. In each case, the model that was presented

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provided the best data fit in which all independent variables were statistically significant.

In examination of all of the "best" models, the major trend noted was that sex appeared as the only consistently significant predictor variable, not an unexpected finding judging from past research. The sex effect was also noted in various interactions with race and driver training. Race and I.Q. were the only other main effects indicated as significant in any of the models, and the I.Q. effect was somewhat confusing.

Of most importance to the goal of this study was the lack of significance shown for the driver training variable. In none of the over 50 models analyzed, did the range-trained group appear different from the non-range-trained sample. Interactions involving the driver training variable in some models indicated that differences due to sex and race were increased in the range group. The only significant contrast between the range and non-range samples occurred in the model predicting the proportion of drivers involved in any accident during the two years subsequent to licensing. Here, the non-white male subset indicated a higher proportion in the range sample than in the non-range, a finding in the opposite direction from what might be hoped for by range advocates.

The analyses conducted thus far indicated that the range trained students in the sample are no different from the students receiving standard training in terms of proportion of subjects involved in accidents. Further analyses will examine both mean numbers of accidents and violations and costs of the programs.

Mean numbers of accidents and violations for subsets.

The first series of analyses concerning the proportion of involved drivers basically examined two subsets of drivers; those who were involved in accidents and those who were accident free. Because of their nature, these analyses could not examine whether or not certain subgroups had experienced a higher absolute number of accidents. It might be hypothesized that while the proportion of involved drivers in two gropus might not be significantly different, one group might include more persons with multiple accidents or violations than the other, an occurrence which would not be reflected in the initial regression analyses. In order to further examine this question, the mean number of accidents and violations per 100 drivers in each race/sex subset was calculated, and the range sample means were compared to the non-range means. This was done using the chi-square test under the assumption that the number of accidents (or violations) a person has is variable with a Poisson distribution. The significance level will be indicated in parentheses as follows:

($p < .05$) denotes that the probability that the differences between means being tested are within the range of random error in sampling is less than .05;

(n.s.) denotes that the difference in the means can be explained in terms of random sampling fluctuations and therefore are not significant.

<u>Mean number of total accidents/100 drivers in two years following licensing.</u>

Just as in the previous analyses concerning accident-involved drivers, the present data were first categorized into cells by driver training, race, sex, and I.Q. (see Table 11).

The analysis of this data indicated significant differences in means at the $p < .05$ level in three subsets. For the white females with I.Q. of 101-110, the range sample accumulated a greater average number of violations than the non-range sample. In similar fashion, for the non-white males in both of the lower I.Q. groups, the mean for the range group was significantly larger. Contrasting this trend were the means of the white males with low I.Q.'s (< 90) and the white females with I.Q.'s of 90-100. In these two groups, the analysis showed differences which were marginally significant ($p < .10$, $p < .20$ respectively) with the range group having a lower mean number of violations than the non-range group.

A second series of tests was conducted on mean number of accidents for subsets categorized by training, sex, race, and age at day of licensing. The information calculated is shown in Table 12. The tests indicated one highly significant difference in means and three differences which are only marginally significant. The mean for 16-year-old non-white males who received range training was significantly higher than the mean for the non-range control group ($p < .01$). In like fashion, the 17-year-old white females receiving range training had a higher mean number of accidents than their non-range counterparts ($p < .10$). On the other hand, the two differences which proved to be only marginally significant ($p < .20$) were in the opposite direction, with both the 17-year-old white males and the 18-year-old non-white females having lower averages in the range groups.

Table 11. Mean accidents/100 drivers in two years following licensing for subjects categorized by training, race, sex, and I.Q.

		Range		Non-range		
	IQ	n	Accidents/ 100 drivers	n	Accidents/ 100 drivers	p
White male	< 90	83	30.12	67	50.75	<.10
	90-100	95	48.42	103	39.81	n.s.
	101-110	97	46.39	116	47.41	n.s.
	>110	109	32.11	110	34.55	n.s.
White female	< 90	41	31.71	54	35.14	n.s.
	90-100	71	15.49	89	25.84	<.20
	101-110	94	28.72	89	14.61	<.05
	>110	108	17.59	120	20.00	n.s.
Non-white male	< 90	31	45.16	89	17.98	<.05
	90-100	10	80.00	28	10.71	<.05
	101-110	0	0	15	26.66	n.s.
	>110	2	100.00	7	28.57	n.s.
Non-white female	< 90	7	0	63	7.93	n.s.
	90-100	6	33.33	29	13.79	n.s.
	101-110	3	33.33	14	14.29	n.s.
	>110	26	0	19	0	n.s.

Table 12. Mean accidents/100 drivers in two years following licensing for subjects categorized by training, race, sex, and age at day of licensing.

		Range		Non-range		
	Age	n	Accidents/ 100 drivers	n	Accidents/ 100 drivers	p
White male	16	444	39.64	392	41.33	n.s.
	17	31	29.03	23	56.52	<.20
	18	16	37.50	9	33.33	n.s.
White female	16	375	21.87	338	23.37	n.s.
	17	22	13.64	18	0	<.10
	18	11	9.09	10	10.00	n.s.
Non-white male	16	58	51.72	99	19.19	<.01
	17	18	27.78	30	30.00	n.s.
	18	10	10.00	28	14.29	n.s.
Non-white female	16	19	10.53	73	8.22	n.s.
	17	10	10.00	29	20.69	n.s.
	18	15	0	24	8.33	<.20

Because the sample sizes in many of these cells were small, the data were summed over age into race/sex categories and similar tests were conducted.

Table 13. Mean accidents/100 drivers in the two years following licensing categorized by training, race, and sex.

	Range		Non-range		
	n	Accidents/ 100 drivers	n	Accidents/ 100 drivers	p
White males	491	38.90	424	41.98	n.s.
White females	408	21.08	366	21.86	n.s.
Non-white males	86	41.86	157	20.38	<.01
Non-white females	44	6.82	126	11.11	n.s.

The data indicated essentially identical mean numbers of accidents in three of the four groups. In the final group, the non-white males receiving range training (weighted heavily by the 16-year-olds in the previous table) had a significantly higher mean than their non-range counterparts.

Mean number of at-fault accidents/100 drivers during the first two years.

As was noted in the earlier regression analyses concerning the proportion of accident-involved drivers, there are differences between all accidents and at-fault accidents as a driving skills measurement criteria. In order to parallel those earlier analyses, the mean number of at-fault accidents for the two year period was examined.

Initially, the data were categorized into subgroups by training, race, sex, and four I.Q. levels. Three marginally significant differences were noted at the p < .20 level -- difference between range and non-range samples for white males and non-white males with I.Q. between 90 and 100 and white females with I.Q.'s between

101 and 110. In all three cases, the range sample had higher average numbers of at-fault accidents than the non-range sample.

Because of the small sample sizes, the at-fault data were combined into race/sex categories for each sample as shown below.

Table 14. Mean number of at-fault accidents/100 drivers in two years following licensing categorized by training, race, and sex.

	Range		Non-range		
	n	At-fault Accidents/ 100 drivers	n	At-fault Accidents/ 100 drivers	p
White males	491	14.9	424	12.0	n.s.
White females	408	5.9	366	6.3	n.s.
Non-white males	86	16.3	157	12.8	n.s.
Non-white females	44	2.3	126	3.2	n.s.

None of the differences is significant. The marginally significant differences indicated in the previous table disappear when the I.Q. and missing I.Q. data are combined.

Mean number of total accidents/ 100 drivers for the first six months following licensing.

Just as before, in order to examine the initial effect of the training program, the data for the first six months following licensing were analyzed.

Just as for the two-year period, data concerning training, race, sex, age, and I.Q. were analyzed first. No significant differences were found in any of the subsets. Again, many of the cells contained small numbers of accidents, reflecting the low accident frequencies in the first six-month period and the reduced samples of subjects on whom I.Q. data were available.

The first six months' data were also categorized by race, sex, and age at day of licensing. The statistical testing indicated only two marginally significant differences. At the $p < .10$ level, the average number of accidents for the range trained non-white 17-year-old females ($n = 10$) was lower than that of the control group receiving standard training ($n = 29$). At the $p < .20$ level, the mean of the range trained 17-year-old white females ($n = 22$) was higher than that of their counterparts ($n = 18$).

Because the frequencies were small, the data were again combined into race/sex categories as shown below.

Table 15. Mean accidents/100 drivers in the first six months following licensing categorized by training, race, and sex.

	Range		Non-range		
	n	Accidents/ 100 drivers	n	Accidents/ 100 drivers	p
White males	491	12.42	424	12.97	n.s.
White females	408	6.37	366	7.38	n.s.
Non-white males	86	13.95	157	8.92	n.s.
Non-white females	44	2.27	126	4.76	n.s.

As is noted, the analyses indicated that none of the differences was significant at the $p < .20$ level.

Mean number of at-fault accidents/100 drivers during the first six months.

Just as for the two-year data, the at-fault accidents which occurred during the first six months following licensing were categorized by training, race, sex, and I.Q. and were examined. Analyses of means indicated no differences significant at the $p < .05$ level. Marginally significant differences were found in three subsets. The range-trained white males having I.Q.'s between 90 and 100 and greater than 110 had been involved in more at-fault accidents than their non-range counterparts ($p < .10$ and $p < .20$, respectively). Conversely, the white females with I.Q.'s between 90 and 100 who received range training had fewer at-fault accidents than the non-range sample ($p < .10$).

When the I.Q. data were left out and the data were categorized by training, race, and sex, none of the differences was significant. Again, the number of at-fault accidents during the first six months is low in all cells.

<u>Mean number of days to first accident.</u>

The final major analysis of the accident data involved comparisons of the average number of days between licensing and the first accident for subjects in the range and non-range groups. It might be hypothesized that the enhanced range-training would delay the occurrence of an accident. Because the accident data collected concerned only the first two years following licensing, there is no way of determining the total number of days to the first accident for all subjects since many were not involved in an accident in their first two years of driving. Thus, the data analyzed concerned only those subjects involved in accidents. As was indicated by the earlier regression analyses, there was no significant difference between the proportion of accident-involved (or accident-free) subjects in the range and non-range groups (i.e., no significant range effect). The proportion of subjects who were accident-free for the two-year period is presented below.

Table 16. Proportion of accident-free subjects characterized by training, race, and sex.

	Range	Non-range
White male	55.6	55.7
White female	82.4	84.7
Non-white male	60.5	66.9
Non-white female	90.9	90.5

The average number of days to first accident for each race/sex subset is shown on the following page.

Table 17. Average number of days to first accident involvement categorized by training, race, and sex.

	Range		Non-Range		
	n	Average Number of Days	n	Average Number of Days	p
White male	218	306.8	188	325.0	n.s.
White female	72	371.8	56	316.1	<.10
Non-white male	34	287.1	52	330.4	n.s.
Non-white female	4	234.0	12	309.0	n.s.

The average days are not significantly different in three of the four groups although the non-range sample had larger means in three cases. However, in the remaining case, the white female subset, the group receiving the range training had a larger mean (i.e., a longer period of time) than their non-range controls.

Mean number of violations/100 drivers in two years following licensing.

Although accident rates provide perhaps the best measure of driving ability, another variable which can also be used as a measure of "good," or at least lawful, driving is violations. For this reason, the driving histories of the range and non-range samples were also searched for data on violations. It is noted that a violation is not entered on a driving record unless a driver is convicted of the unlawful offense.

To examine this variable, analyses parallelling the ones in the previous sections were conducted. Mean numbers of violations/100 drivers for the various training, race, sex, I.Q., and age categories were compared. Significant differences in means at the $p < .05$ level are found in the white male, I.Q. = 90-100, subset and the white female, I.Q. = 101-110 subset. In both cases, the range sample accumulated more violations than the non-range sample. Two other similar differences of marginal significance ($p < .10$) are noted. In both the subset of white males with I.Q. between 101 and 110 and the subset of non-white males with I.Q. between 90 and 100, the range sample accumulated more violations on the average. The data were also categorized by race, sex, and age at initial licensing, and mean numbers of violations were compared for the range and control groups. These data are shown in Table 19.

As in other analyses, obvious differences are noted in comparing the means of males to those of females in both race and training groups. The higher average number of violations for males probably reflects more exposure and perhaps more unlawful driving. Comparisons between training groups indicated only three notable differences, and all three are only marginally significant. The 16-year-old white males who received range training had a higher number of violations than their non-range counterparts ($p < .10$). On the other hand, the 16-year-old non-white females receiving range training accumulated less violations than the non-range sample ($p < .10$). The only other subset showing a notable differance was the 16-year-old non-white male, where the range group had more violations than the non-range ($p < .20$), but this could have partially resulted from this group's over-representation in accidents noted earlier.

Table 18. Mean number of violations/100 drivers over two years following licensing for subjects categorized by training, race, sex, and I.Q.

		Range		Non-range		
	I.Q.	n	Violations/ 100 drivers	n	Violations/ 100 drivers	p
White male	< 90	83	81.9	67	79.1	n.s.
	90-100	95	105.3	103	75.7	<.05
	101-110	97	80.4	116	61.2	<.10
	>110	109	52.3	110	55.5	n.s.
White female	< 90	41	36.6	54	22.2	n.s.
	90-100	71	22.5	89	31.5	n.s.
	101-110	94	22.3	89	6.7	<.05
	>110	108	14.8	120	17.5	n.s.
Non-white male	< 90	31	48.4	89	49.4	n.s.
	90-100	10	100.0	28	42.9	<.10
	101-110	0	0	15	46.7	n.s.
	>110	2	50.0	7	42.9	n.s.
Non-white female	< 90	7	0	63	6.3	n.s.
	90-100	6	50.0	29	17.2	n.s.
	101-110	3	0	14	21.4	n.s.
	>110	2	0	1	100.0	n.s.

Table 19. Mean violations/100 drivers in two years following licensing for subjects categorized by training, race, sex, and age at day of licensing.

		Range		Non-range		
	Age	n	Violations/ 100 drivers	n	Violations/ 100 drivers	p
White male	16	444	76.80	392	66.07	<.10
	17	31	70.97	23	104.35	n.s.
	18	16	50.00	9	44.44	n.s.
White female	16	375	21.60	338	20.41	n.s.
	17	22	4.09	18	0.00	<.20
	18	11	0.00	10	10.00	n.s.
Non-white male	16	58	67.24	99	51.52	n.s.
	17	18	33.33	30	36.67	n.s.
	18	10	30.00	28	50.00	n.s.
Non-white female	16	19	5.26	73	16.44	<.10
	17	10	20.00	29	10.35	n.s.
	18	15	6.67	24	4.17	n.s.

Again, these data were summed over age to increase sample size (see Table 20).

Table 20. Mean violations/100 drivers for two years following licensing for subjects categorized by training, race, and sex.

	Range		Non-range		
	n	Violations/ 100 drivers	n	Violations/ 100 drivers	p
White male	491	75.56	424	67.69	<.20
White female	408	20.34	366	19.13	n.s.
Non-white male	86	55.81	157	48.41	n.s.
Non-white female	44	9.09	126	12.09	n.s.

Here, the only even marginally significant difference noted is in the white male group. The range-trained sample received a higher number of violations than the non-range counterpart ($p < .20$).

Mean number of violations/100 drivers for first six months following licensing.

In order to examine the short term initial effects of the range training on driving as indicated by violations, the violation data from the first six months of the subjects' driving history were analyzed. Again, the initial categorization was by training, race, sex, and I.Q. (see Table 21).

The data indicate that white males in the lowest I.Q. group (< 90) had 33.7 violations per hundred drivers in the range group and only 19.4 in the non-range ($p < .1$). Non-white males in a mid-I.Q. group (90-100) also had more violations in the range group, a difference marginally significant at the $p < .20$ level. Conversely, white females in the high I.Q. group had fewer violations in the range group ($p \leq .05$). All other differences were non-significant. Again, the small sample sizes in some cells must be noted.

Table 21. Mean violations/100 drivers in the first six months after licensing for subject categorized by training, race, sex, and I.Q.

		Range		Non-range		
	I.Q.	n	Violations/ 100 drivers	n	Violations/ 100 drivers	p
White male	< 90	83	33.7	67	19.4	<.10
	90-100	95	23.2	103	18.4	n.s.
	101-110	97	22.7	116	18.1	n.s.
	>110	109	12.8	110	10.0	n.s.
White female	< 90	41	12.2	54	5.6	n.s.
	90-100	71	2.8	89	6.7	n.s.
	101-110	94	3.2	89	1.1	n.s.
	>110	103	0.9	120	5.8	<.05
Non-white male	< 90	31	19.4	89	15.2	n.s.
	90-100	10	40.0	28	7.1	<.20
	101-110	0	0	15	13.3	n.s.
	>110	2	0	7	0	n.s.
Non-white female	< 90	7	0	63	3.2	n.s.
	90-100	6	0	29	3.4	n.s.
	101-110	3	0	14	0	n.s.
	>110	2	0	1	100.0	n.s.

When these data were categorized by only training, race, and sex (i.e., without I.Q. levels), only one difference remained significant at the $p < .10$ level (see Table 22).

Table 22. Mean violations/100 drivers in the first six months after licensing for subjects categorized by training, race, and sex.

	Range		Non-range		
	n	Violations/ 100 drivers	n	Violations/ 100 drivers	p
White males	491	22.00	424	16.51	<.10
White females	408	3.92	366	4.65	n.s.
Non-white males	86	16.28	157	12.10	n.s.
Non-white females	44	2.27	126	3.18	n.s.

The white males receiving range training accumulated more violations during this time period than did their counterparts receiving the standard training. None of the other differences is even marginally significant.

Mean number of days to first violation.

For each subject convicted of a traffic offense during the first two years subsequent to licensing, the number of days to the first such offense was calculated. As was noted on page 30 in the discussion of "days to first accident," analysis of these data might reveal subtle differences between samples under the hypothesis that enhanced training would affect driving behavior for a longer period of time than a standard training course. Again, this analysis only involved drivers who experienced a violation during the two years examined. Violation-free subjects are deleted. Just as in the similar analysis for days to first accident, the white female subset receiving range training experienced a longer time period before violations than the non-range sample ($p < .05$). While obvious differences exist between males and females within

Table 23. Average number of days to first violation for subjects categorized by training, race, and sex.

	Range		Non-Range		
	n	Average number of days	n	Average number of days	p
White male	146	309.1	135	309.9	n.s.
White female	74	348.2	65	279.6	<.05
Non-white male	28	274.4	29	278.5	n.s.
Non-white female	3	387.0	13	246.3	n.s.

races, no other significant differences exist between the range and non-range samples.

Analysis of accident severity.

The final comparison of driving record data of the range and non-range sample involved accident severity. Severity is to be measured by the proportion of injury and non-injury accidents in the total number of accidents accumulated by each sample. Tables 24 and 25 present the total number of accidents, the number of injury producing accidents, and the percentage of the total accidents which are injury accidents for both the six-month and the entire two-year periods.

(For analysis purposes, the number of injury and non-injury accidents within each race/sex group for the range sample were compared to the corresponding frequencies in the non-range sample using a χ^2 statistic. This is equivalent to comparison of proportions of injury accidents within each group.) The analyses of these data indicated two marginally significant differences. In the white male subset, the range sample experienced a lower proportion of injury accidents than the non-range sample during the first six-month period ($p < .10$). In addition, when all race and sex groups are combined in the line labeled "total," the same type of difference exists ($p < .10$). These findings disappear in the two year data where the analyses revealed no significant differences.

Summary of results of analyses concerning means.

Thus, in the second major series of analyses, mean number of accidents and violations per driver and mean number of days to first accident and first violation were calculated for each of the two samples. Comparisons of these means were carried out between range and non-range samples within the various race, sex, age, and I.Q. subsets. Four differences between accident means were noted as significant at the $p < .05$ level. All four cases involved white and non-white males of various I.Q. and age subsets and in each case, the range-trained sample had a higher average number of total accidents over the two-year period. Many marginally significant differences were noted both in total accidents and at-fault accidents for the two time periods. These differences were almost equally split between cases in which the range group accumulated more accidents than the non-range group and cases in which the range-trained group experienced fewer accidents than the non-range sample. When larger subsets were compared (i.e., when age and I.Q. data were not involved) the differences disappeared in all cases except the non-white male finding

Table 24. Accidents classified by severity for the first six months following licensing.

	Range			Non-range			
	Total Accidents	Injury Accidents No.	Injury Accidents % of total	Total Accidents	Injury Accidents No.	Injury Accidents % of total	p
White male	62	5	8.06%	55	12	21.82%	<.10
White female	26	3	11.54%	27	5	18.52%	n.s.
Non-white male	12	2	16.67%	14	1	7.14%	n.s.
Non-white female	1	0	0.00%	6	3	50.00%	n.s.
Total	101	10	9.90%	102	21	20.59%	<.10

Table 25. Accidents classified by severity for the two years following licensing.

	Range			Non-range			
	Total Accidents	Injury Accidents No.	Injury Accidents % of total	Total Accidents	Injury Accidents No.	Injury Accidents % of total	p
White male	192	39	20.31%	178	31	17.42%	n.s.
White female	86	23	26.74%	80	23	28.75%	n.s.
Non-white male	36	11	30.56%	32	5	15.63%	n.s.
Non-white female	3	1	33.33%	14	4	28.57%	n.s.
Total	317	74	23.34%	304	63	20.72%	n.s.

cited above. While the subsets involving range-trained non-white males seemed to be characterized by higher accident means, those involving the range-trained white females appear to be characterized by lower mans than their non-range control groups.

Very little difference existed in the analysis of accident severity. The only marginally significant difference found indicated that, given that the subjects were involved in accidents during the first six months following licensing, the range-trained groups were involved in slightly less severe ones.

Analysis of violation accumulations also indicated a somewhat contrasting results. Again, four differences were found to be significant at the $p < .05$ level. While the range-trained white subjects of both sexes in the lower I.Q. groups accumulated more violations over two years, the range-trained white females in the higher I.Q. subset accumulated significantly fewer violations than their counterparts during the first six months, and the range trained white females' elapsed days to first violation was greater than that of the similar control group. Again, various marginally significant differences were noted ($p < .20$). There appeared to be a somewhat more consistent trend in these differences in that the range-trained sample was characterized more often by the higher mean number of violations.

Just as for the previously discussed regression analysis results, these findings are far from being clear-cut as to whether a real difference exists between range and non-range students. The lack of many highly significant results and the lack of clear trends in both the highly and marginally significant findings again indicate that there appears to be no major differences in the driving behavior of students undergoing range and standard training courses. In the next section, data concerning comparison of costs for these two programs are presented.

Analysis of Cost-Effectiveness of the Range and Standard Programs

As was indicated in the Introduction Section, two basic hypotheses were to be examined. The first involved whether the students receiving the enhanced driver education training on the ranges were subsequently "better" drivers than a control group of students receiving the standard training. The second hypothesis involved whether or not the range programs resulted in a higher output of trained drivers for each dollar spent.

The former hypothesis has been examined in the previous sections using analyses of the accident and violation histories of the two groups. The results have indicated that there appears to be little difference between the driving histories of the range and non-range samples. Thus, it might be argued that since the range program is providing training as good as the standard program, it would be beneficial to the state if it is training a larger number of students for each program dollar spent. This question of cost-effectiveness will be examined in this section.

Cost-effectiveness analysis usually involves the comparison of the cost of two or more programs which are equally effective at meeting a given goal. Our goal is the production of a "better" trained driver. The previous analyses allow us to tentatively conclude that both the range and standard programs are of equal effectiveness, at least as measured by subsequent driving history. Thus, costs per student for each of the two programs will be examined.

An attempt was made to gather data on three groups of schools, (1) the seven original range programs, (2) a group of non-range programs within the same county as a range program, and (3) a randomly selected group of eight non-range schools from across the state. Data were successfully collected on the third group. However, problems were encountered with the first two groups because of the nature of available information. In all cases, the cost data used were extracted from files held at the N.C. Department of Public Instruction, and the vehicle-related and teacher-related costs were recorded by county on a yearly basis. Thus, in situations where some students in a given school were given range training while others received non-range training, it was impossible to accurately divide teacher costs into "range-related" and "non-range related" categories. This was a common occurrence in some counties where students taking driver education during the summer were given range training while those taking it during the school term received the standard "30 and 6" program. As will be noted later, a similar problem existed with vehicle costs.

For these reasons, usable data for range programs could only be gathered for the three ranges where all the students in the county took range training. This resulted in a small sample of cost information which, of course, somewhat limits the inferences which can be drawn. It is also noted that only two of the range programs ultimately used were in the original group of seven, the third program having begun operation in 1973. Thus, the cost-effectiveness analysis is not as closely linked to the earlier accident-related analyses as would be desired.

In an attempt to make the range and non-range costs data somewhat more comparable, a third set of data was collected. This set included cost data for the three range programs prior to the construction of the range (i.e., when the driver education programs offered in these same counties were totally non-range in nature). Thus, three cost-related data sets were examined, (1) cost data for a group of three range programs where all students in the county received range training, (2) cost data on the same three programs in prior, "non-range" years, and (3) cost data on a group of eight non-range schools randomly selected from across the state.

As indicated above, the basic corrected data can be divided into three subsets -- (1) teacher cost, (2) vehicle cost, and (3) site cost--with component parts as follows:

1. Teacher Costs
   - Salaries of full-time driver education teachers
   - Salaries of part-time (summer) instructors
   - Salaries of range coordinators

2. Vehicle Costs
   - Operational costs including fuel, insurance, and maintenance
   - Auxiliary equipment costs (warning signs, dual braking systems, etc.)

3. Site Costs
   - Range construction and maintenance costs
   - Equipment costs
     - "Simulators"
     - "Drivocators"
     - Traffic cones, signs, markings, communications equipment, etc.

4. Number of Students Trained

While the listing of such data items is relatively simple, as was noted in the previous discussion, the collection of accurate data was very difficult to obtain. Problems in teacher cost data were discussed. Problems in vehicle costs were also found. For example, in most instances, vehicle operational expenses were kept only on a county-wide basis, and no data existed on the costs for vehicles at a particular school. This caused greatest difficulty where a range program involving 10-12 cars and one or more non-range programs involving one or two cars both existed in the same county and led to the deletion of some schools from the original sample. In order to extract the required data for the schools in the sample, the following procedures and related assumptions were used:

1. For non-range schools located in counties having only non-range programs, the share of the total county-wide vehicle costs attributed to the school in question was determined by a ratio of the number of driver education students in the sample school to the total number of driver education students in the county. The implied assumption here is that each student in the county drives approximately the same number of miles.

2. For range schools in counties teaching only range programs, the total county vehicle costs were assumed to be range-related.

3. For non-range schools which taught all students in a given county (i.e., group (2)), the total county vehicle costs were assumed to be non-range program related.

4. The range and non-range schools located in the same county, the county-wide vehicle costs were prorated on a total program mileage basis. That is, estimates of the number of miles driven per student in the range program and in the non-range program were obtained from the teachers at the schools. The estimate of total mileage driven for all range schools was obtained by multiplying the figure estimated for the range program in the sample by the total number of range students taught in the county. The total miles traveled in the non-range program was calculated in a similar fashion. The total funds were then prorated on a basis proportional to these mileages. The costs for the range schools <u>in the sample</u> were derived by multiplying the total range cost in the county by

$$\frac{\text{no. of students in the sample program}}{\text{no. of students in all range programs}}$$

The site costs were usually associated only with the range programs since the standard "30 and 6" programs use existing public roadways. In order to estimate annual costs for the range and related equipment ("simulators," etc.), all construction and "initial" equipment costs (e.g., simulator costs) were first brought back to the same base year through use of present worth methodology. The total range and equipment costs were then amortized over a 20 year period to provide an estimated annual site cost. In all economic calculations, an interest rate of 10 percent was assumed to be the cost of money to the state. This average discount rate was based on the current marginal borrowing rate for public agencies making investments, as discussed in a recent paper concerning roadway safety improvements (Council and Hunter, 1975). (To further insure that the discount rate chosen was not the controlling factor in the subsequent results, the calculations were repeated using a five percent rate.)

Finally, total teacher costs were calculated as the sum of driver education teacher costs for a given school or county in a given year, plus the related teacher costs associated with the range coordinators. As noted earlier, the coordinators were hired by the State Department of Public Instruction to coordinate use of the range, to teach on the range, and to provide assistance to other driver education teachers in curriculum development and other areas. Because some of the coordinators were responsible for more than one range, the coordinator costs were assigned to a given range on a proportional basis. That is, if a given coordinator was responsible for three range sites and programs in a given year, one-third of his salary was attributed to a given range program, the assumption being made that his time would be equally split among all ranges under his control.

Thus, for each school or range program, annual amounts for teacher costs, vehicle costs and site costs were calculated. Each of the three components of cost was then divided by the number of students trained to get a cost per student, and these three components were summed to give a total cost per student. The resulting costs/student for each year using a 10 percent discount rate are shown in Table 26.

In order to compare the range and non-range costs, the 1968 present worth of each annual cost/student for a given school was calculated. For example, for Cleveland County, a non-range program, this series of calculations resulted in five estimates of total annual cost/student in 1968 dollars. For Chowan, a range program, three estimates resulted. The 1968 estimates for a given school were then averaged to provide the average cost/student. These averages are shown in Table 27.

The resulting figures indicate that the average cost/student is somewhat higher for the range programs than for the non-range programs in the sample. For the randomly selected non-range schools, the average cost/student (in 1968 dollars) varies from $22.98 to $52.11, with five of the eight schools consistently indicating costs around $42. The overall average (not weighted by number of students) is $40.10. For the non-range schools which later became range programs, the annual cost/student is somewhat less consistent, and averages $37.42. The cost/

student for the three range programs (Group 1) is even more varied, ranging from $42.44 to $81.00, with an average of $61.98, some $20/student higher than the non-range estimates. It is also noted that in all three cases, the group 2 schools indicate lower average costs when they are non-range schools.

The corresponding calculations using a five percent discount rate indicated an overall average for the randomly selected non-range schools of $47.18, and an average for the non-range schools which later became range programs of $39.36. The recalculated average cost for the range programs was $71.89, again indicating a cost/student differential of over $20.00.

It appears that, with the exception of the range programs, there were increases in costs which were not paralled by increases in the number of students trained. The individual cost components in Table 26 for groups 1 and 2 indicate that these increases in total cost/student are the result of increases in site costs (as would be expected) and increases in teacher costs. Again, these data are severely limited by group 1, range-related sample size. Because of this, strong inferences to the total state range program cannot be drawn. However, there are no indications that the cost/student is <u>lower</u> for the range programs monitored.

Table 26. Cost/student for the three data subsets examined.

		1968	1969	1970	1971	1972	1973	1974
Group 1 (Range programs)								
No. 1	Teacher cost			75.15	72.83	56.53	82.87	71.75
	Vehicle cost			4 27	13.52	6 77	—	—
	Site cost			23.43	25.77	27.75	27.75	28.91
	Total			102.85	112.12	91.05	—	—
No. 2	Teacher cost						56.15	35.00
	Vehicle cost						3.29	4.32
	Site cost						17.35	17.65
	Total						76.79	56 97
No. 3	Teacher cost						64.36	103.52
	Vehicle cost						10.66	15.83
	Site cost						19.61	20.24
	Total						94.63	139.59
Group 2 (Group 1 programs in prior non-range years)								
No. 1	Teacher cost	39.26	38.83					
	Vehicle cost	3.84	4.81					
	Total	43.10	43.64					
No. 2	Teacher cost	36.00	36.00	36.00	36.00	32.00		
	Vehicle cost	4.38	5.31	4.05	3.19	3.78		
	Total	40.38	41.31	40.05	39.19	35.78		
No. 3	Teacher cost	35.62						
	Vehicle cost	2.27						
	Total	37.89						

Table 26 (continued)

Group 3
(Randomly selected non-range programs)

No.1	Teacher cost	47.92	36.94	42.45	—	76.01	70.90
	Vehicle cost	3.36	3.25	3.75	4.37	4.65	4.80
	Total	51.28	40.19	46.20	—	80.66	75.70
No.2	Teacher cost	44.97	51.04	56.29	—	58.31	63.41
	Vehicle cost	3.33	4.84	4.61	4.93	3.99	5.06
	Total	48.30	55.88	60.90	—	62.30	68.47
No.3	Teacher cost	45.87	46.82	46.08	48.62	66.86	68.38
	Vehicle cost	4.10	3.58	4.24	3.62	3.92	6.84
	Total	49.97	50.40	50.32	52.24	70.78	75.22
No.4	Teacher cost	46.88	41.63	—	76.33	54.52	66.72
	Vehicle cost	3.92	4.27	3.53	1.61	4.02	6.49
	Total	50.80	45.90	—	77.94	58.54	73.21
No.5	Teacher cost	48.20	47.48	40.63	36.32	33.65	47.31
	Vehicle cost	1.56	1.75	1.68	2.33	3.88	6.36
	Total	49.76	49.23	42.31	38.65	37.53	53.67
No.6	Teacher cost	43.88	49.65	49.32	77.03	56.72	72.02
	Vehicle cost	4.58	4.78	3.63	4.71	4.58	6.60
	Total	48.46	54.43	52.95	81.74	61.30	78.62
No.7	Teacher cost	42.40	11.11	23.33	33.95	15.79	33.28
	Vehicle cost	4.29	5.23	4.22	4.20	4.66	6.58
	Total	46.69	16.34	27.55	38.15	20.45	39.86
No.8	Teacher cost	40.00	65.33	76.92	71.72	85.86	73.25
	Vehicle cost	4.29	5.23	4.22	4.20	4.66	6.58
	Total	44.29	70.56	81.14	75.92	90.56	79.83

Table 27. Average cost/student for the three data subsets in 1968 dollars (assuming a 10% annual interest rate).

Group 1	Group 2	Group 3
81.00	41.39	41.47
42.44	32.98	42.64
62.50	37.89	41.16
		43.00
Average = 61.98	Average = 37.42	32.95
		44.51
		22.98
		52.11
		Average = 40.10

V. SUMMARY AND CONCLUSIONS

In 1973, the North Carolina Department of Public Instruction and the University of North Carolina Highway Safety Research Center initiated a joint project aimed at evaluating and upgrading the range-related driver education program in the state. Part of this overall project was an evaluation of the performance of students receiving the training. This report specifically deals with a comparative analysis of the driving records of students involved in initial range training and a control group of students involved in the more standard non-range training. An attempt was made to determine whether or not differences between the two types of training are reflected in the accident and violation histories of the two groups.

The methodology employed included sampling the class rolls of the seven original range programs and of seventeen randomly chosen non-range schools for the same school year, linking names with subsequent driving history as recorded by the N.C. Department of Motor Vehicles, and comparatively examining the resulting data by various accident and violation classes (e.g., total vs at-fault) and time periods (i.e., six months and two years subsequent to licensing). The analyses conducted involved fitting general linear models to the proportion of involved drivers (the CATLIN computer package), and comparing the mean numbers of accidents and violations for various race/sex/I.Q. subgroups. In addition, an attempt at cost-effectiveness analysis was made to examine hypothesized lower cost/student due to higher output.

As indicated in the previous sections, the results are not consistent with what range program advocates might wish. The categorical analyses indicate no significant differences between the range group and the control group based on accident histories in any of the 50+ models analyzed. The only significant difference noted was that in the non-white male subset, a higher proportion of range-trained students were involved in accidents, a finding in the opposite direction from what might be hoped for. The various analyses involving the mean numbers of accidents and violations per student for given time periods also indicated the same trends. In the few cases where significant differences existed, the range-trained subset of students exhibited higher means than their control group counterparts. As noted on page , marginally significant differences in accidents were also equally split between cases where the range students were "better" and cases where they were "worse." Differences in the mean numbers of violations were also very small, and any "trend" was toward the range group accumulating higher numbers of violations. As noted earlier, the lack of many highly significant results and the lack of clear trends in findings again indicates that there appears to be no major difference in the driving behavior of the students undergoing range training as opposed to non-range training when such behaviors are measured in terms of accidents and violations.

Thus, these findings all seem to indicate the lack of measurable change in the driving behavior of inexperienced drivers which could be attributed to the range programs under study. However, before inferences are drawn to the entire N.C. program, the authors feel that there must be some discussion on three possible limitations of the data used.

First, it is noted that because of the need for accumulation of accident and violation histories, it was necessary to use 1970-71 students from the earliest range programs, and thus the data studied are somewhat "old." The teaching procedures, curriculum, and other factors may have changed over time as experience was gained, and these differences might now be resulting in some measurable effect. This hypothesis will be further tested in a subsequent analysis of driver license test performance of more recent range and non-range students.

Second, and perhaps most important, is the question of whether or not the implied assumption of "all other things being equal" held, and therefore whether or not the lack of difference was a true reflection of the range program benefits or was a reflection of other factors. The most obvious factor which could have clouded the results would be differential amounts of driving exposure between the experimental and control groups. As was noted in the Methodology Section, it was assumed that the initial seven ranges were located at random across the state, and that there were no inherent biases such as community economic status which would affect the results. Obviously, differences in economic status might well affect vehicle ownership, and ultimately the mileage driven by young drivers. Previous studies (Waller, 1970) have indicated that the more affluent, white, young driver is more likely to accumulate accidents and violations than the population at large, probably because of exposure differences and possibly because of attitudinal differences. Differences in the urban/rural characteristics of range and non-range schools may also have affected the type of exposure experienced, another important factor in accident accumulation. The question that remains then is whether or not such biasing differences could have existed in the present data. As might be expected, there were no data available on any measure of socioeconomic level of the individual students or school, making a direct answer impossible. However, there are hints in the present data that such differences may have existed between the range and non-range locations. Specifically, as noted in the discussion of data presented in Table 2, race differences are noted between the range and non-range samples. As indicated, these differences could reflect true race variations between the schools in the two groups and/or differences due to data reporting variations. Further indication of possible variations between communities or schools is noted in the discussion of valid I.Q. data earlier. The fact that the non-range sample exhibited a higher proportion of valid I.Q. information in each race/sex subcategory may reflect variations in sensitivity to releasing such information which could in turn reflect community and school differences. Somewhat counter to this argument, is the lack of range/non-range discrepancy in the average reported I.Q.'s for the race/sex subcategories (see Table 4). Again, if these differences do exist, then the range students might have been expected to accumulate more accidents. If this were the case, then any true program-related difference would have been eroded by exposure difference. Again, such a difference can only be hypothesized.

Finally, there is the question of whether or not accidents and violations are appropriate measure variables for driver education programs. That is, can we realistically expect any training program involving only a relatively limited amount of actual driving experience and some limited number of hours of classroom training to affect the many skill and attitudinal factors which interact in an accident sequence? Some highway safety and training experts have indicated that such an expectation may never be realized. In a discussion of whether or not driving histories provide a realistic tool for measuring driving education success, Waller (1973) notes:

> I do not know of any other high school course that is evaluated on the same terms as driver education. The English teacher is not evaluated on the basis of the correspondence his students write in later life. The math teacher is not evaluated on the basis of how well his students balance their check books. The home economics teacher is not evaluated on the basis of how well the students select or prepare meals. Yet the driver education teacher is held responsible for the subsequent driver records accumulated by his students. One might wonder whether the criteria applied to driver education are realistic. Should the driver education teacher be responsible only for whether the student <u>can</u> drive safely or whether he actually <u>does</u> drive safely? His subsequent <u>performance</u> is the result of many factors (such as peer influence, home pressures, and the student's own personality), which are beyond the influence or control of the driver education teacher (see Carlson and Klein, 1970).

Thus, there is some question of whether the criteria used are realistic. It may indeed be the case that more "immediate" measures of payoff need to be used, both for driver education, per se, and for differences in driver education programs (e.g., range versus non-range training). As was noted earlier, one such measure, the experience of range and non-range students on the N.C. Driver License Road Test, is currently under study as a part of this same overall project. The results of this companion study should be published in the near future. These problems with the criteria used in the current study are real. However, because of the public's expectations of a driver education program, and because, ultimately, both the driver education community and the safety research community hope that driver education will affect driving behavior in a measurable way, and thus wish to continue spending safety funds on these programs, driver histories will, and perhaps should, continue to be used in evaluations.

Some further discussion of the attempt at cost-effectiveness analysis also appears to be warranted. As noted, the applicability of these current findings to the entire N.C. range program is limited by the small amount of usable cost data which was usable. While the assumptions employed appear to be justified, and while the methodology is sound, the amount of cost data available, particularly on the range programs, was smaller than what the authors would desire. It became obvious during the data collection procedure that the cost data currently available on a retrospective basis are not complete enough for a rigorous analysis, and that future attempts at such analysis should be based on "prospectively" collected information, that is, well-designed data on current programs. However, even with the inherent data problems, the analyses conducted do provide some indication that, as in past studies (Jones, 1973), the cost of range programs is higher, and the output of trained students may not have experienced a proportional increase. The authors feel that such cost-effectiveness analysis of safety programs is highly desirable. Programs requiring the limited safety dollars are multiplying, and methods for proper fiscal decision-making must be continually strengthened.

When the findings of current analysis are combined with the discussed limitations of the data, criteria, and methodology, and when an alternative course of action is considered, the authors conclude that there obviously cannot be a recommendation to do away with the program. Such a procedure would be wasteful in view of the existence of range facilities. However, the authors would strongly recommend strengthening the existing program. This strengthening could be accomplished in many ways. Three that may be feasible at present include:

1. Increase usage of existing facilities. As noted in the cost-effectiveness section, it does not appear that student output has experienced a proportional increase in relation to cost increases. The Department of Public Instruction and the local school districts should look into the possibility of increased usage of the ranges by including additional surrounding schools in the program and by actively working to convince other driver education groups (e.g., adult classes) that they can and should use the existing facility. Increased usage must be accomplished in a well-planned, coordinated manner. For example, bringing another school into the range program in which a range coordinator or lead teacher does the teaching will not provide additional benefits unless the teacher time freed up at the home school is used fully in driver education or other areas. Perhaps part-time instructors could be used to teach classroom and on-road segments while the range based instructor would be responsible for all range training. (This, in turn, may require state (D.P.I.) or local funding of the range coordinators, funding which is no longer provided by the Governor's Highway Safety Program). Increased usage may also be the result of additional types of usage, as indicated in 3 below.

2. Continually monitor other national curriculum development programs, research and evaluation efforts, and revise the existing curriculum based on these outputs. North Carolina's range program cannot be faulted for past efforts in range training curriculum upgrading, since very little has been done in this area nationally. However, more emphasis is now being placed on range training, and developments in driving task analyses, emergency skills development, and other areas are being brought to light. Because of the inherent difficulty of doing this monitoring if one has other teaching duties, the possibility of designating one individual at a state level to conduct this work, and to systematically distribute the information to the teachers should be explored. It is noted that with the demise of Better Driving, a publication designed to help meet the need of communication to teachers, there will be an even greater need for a new information distribution system.

3. Modify the current range usage program to include new, innovative training procedures. Increased and "upgraded" range training could result from novel uses of the range. It is recommended that new programs be attempted on a pilot basis on these facilities such that meaningful evaluation can be carried out before statewide implementation is attempted. It is anticipated that two such programs will be attempted during the next project year--(1) a program involving emergency skills training for novice drivers, and (2) a motorcycle driver education program for novice riders. The results of these two programs may well suggest other areas for future use (e.g., bicycle education for children and adults). Other novel uses which should be considered by D.P.I. and the local units include cooperative programs with other departments of government, both state and local. For example, N.C. may well have a motorcycle driver licensing requirement within two years. If so, there will be a need for off-road testing of riders; and use of the existing ranges in this program might be feasible and could save the state some safety dollars. Again, good coordination and planning would be required.

These are but three specific recommendations for strengthening the existing N.C. range program. Just as in all other areas of driver education and highway safety within N.C., the commitment of the individuals involved is readily apparent. Because of the increasing pressure for better usage of highway safety dollars, this commitment must be fully utilized to continue to upgrade the driver education range program.

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