A CASE FOR DIAGNOSTIC TESTS IN DRIVER EDUCATION

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Driver education courses have been made available to almost all novice drivers in an effort to produce safer drivers. Providing the courses for these millions of new drivers requires a large investment in manpower, money, materials, and time. Consequently, the effectiveness of current driver education programs must be continually reassessed. Clearly, if the expenditures on driver education programs are to be justified, evaluation tools must be provided. To be of greatest value, such tests not only must evaluate current programs but also must assist in identifying effective methods to further improve driver education. The ultimate goal of traffic safety effectiveness in driver education is unquestionably accident reduction. However, as many researchers have reported, the use of accident data as an evaluation criterion is undesirable because of their statistical unreliability, i.e., the rarity of occurrence, the multiple causes of accidents, differences in reporting (2, 3). There is, therefore, a need for intermediate criteria that are operationally useful and reliable and related to driving behavior and accidents. In response to the need for evaluative tools, the aims of this project were to

1. Develop objective tests and measures for the assessment of driver characteristics including driver attitude, knowledge, and performance (i.e., skills, judgment, and safe driving practices); and
2. Use these measures of driver attitudes, knowledge, and performance to assess student driver capabilities upon entering the driver education course, on completion of the driver education course, and 1 year after completing the course for comparison with experienced drivers.

During the past 2½ years the Systems Research Group at the Ohio State University and the Nationwide Research Center, in cooperation with the Ohio Department of Education, developed and administered evaluative tests. The Nationwide Research Center developed tests of driver attitudes and knowledge, and the Driving Research Laboratory (of the Ohio State University) developed tests of driver performance (skills, judgment, safe driving practices). Though many interesting and useful results were derived from the attitude and knowledge tests, the focus of this paper is on driver performance.

TEST DEVELOPMENT AND ADMINISTRATION

Test development proceeded in essentially two stages. First, several pilot studies were conducted on a large set of candidate tests and measures. Then, in the main study, a reduced set of the best tests was administered to a large number

of students. In the pilot studies, novice student drivers and experienced drivers were compared in

1. Car handling on a range,
2. Freeway driving,
3. Judgment studies (1),
4. Visual search patterns (4), and
5. Narrow gap negotiation (7).

The tests, measures, and results from the pilot studies were reviewed and reduced to a smaller set of tests to be used in the main study. The final performance tests were selected for their

1. Sensitivity to learning by novices,
2. Discrimination between novices and experienced drivers, and
3. Administrative feasibility (reasonable time to complete, use of noninstrumented vehicles).

In the main study the tests were administered to 71 students before they began driver education. Fifty-seven of these students were again tested after completing driver education, and 38 were retested 1 year after completing driver education. Six experienced drivers who had driven at least 6 years and more than 5,000 miles per year were also tested.

The Ohio Department of Education chose the 10 participating schools to represent a cross section of types of driver education programs. The standard program consisted of about 6 hours of driving time (range was 4 to 8 hours), 18 hours observing other students drive (range was 8 to 22), 36 hours in the classroom (range was 30 to 63 hours), and 6 hours in a simulator (range was 6 to 15 hours). Two schools also had a training range. Individual driving instructors assisted in the random selection of students.

Five range tests were conducted to determine driver performance:

1. Serpentine,
2. Cornering,
3. Narrow gap,
4. Quick lane-change, and
5. Parallel parking.

Data given in Table 1 describe the tests and measures, and course layout is shown in more detail in Figure 1.

Table 1. Skill tests and performance measures.

Test	Description	Measures
Serpentine	Winding track outlined with cones, 12-foot lane width, 120- and 180-degree curves, three trials (last two scored)	Time from beginning to end; cones displaced
Cornering	180-degree curve with inside radius of 19 feet, 12-foot lane outlined with cones; 10 trials (last eight scored)	Cones displaced
Narrow gap	Drive through 100-inch gap at 15 mph; styrofoam posts and plates; 10 trials (last eight scored)	Variance of centerline position of car
Quick lane change	Driver approaches simulated intersection at 20 mph; when light turns red, driver stops if possible or changes to left lane quickly if no time to brake; 10 trials (last seven scored)	Weighted error score
Parallel parking	25 feet by 80 inches; two trials	Time to park, distance from curb

TEST RESULTS

Frequency histograms (Figs. 2 and 3) of the test measures revealed that novice drivers entered driver education with widely varying levels of skills.

In the cornering test (Fig. 2), some novices performed as well as experienced drivers, but most performed poorly. In the quick lane-change test (Fig. 3), experienced drivers had no difficulty responding correctly to the traffic signal, whereas many novices were unable to respond appropriately. Similar results were found in the other tests.

Though the individual test results are

Figure 1. Layout of test tracks.

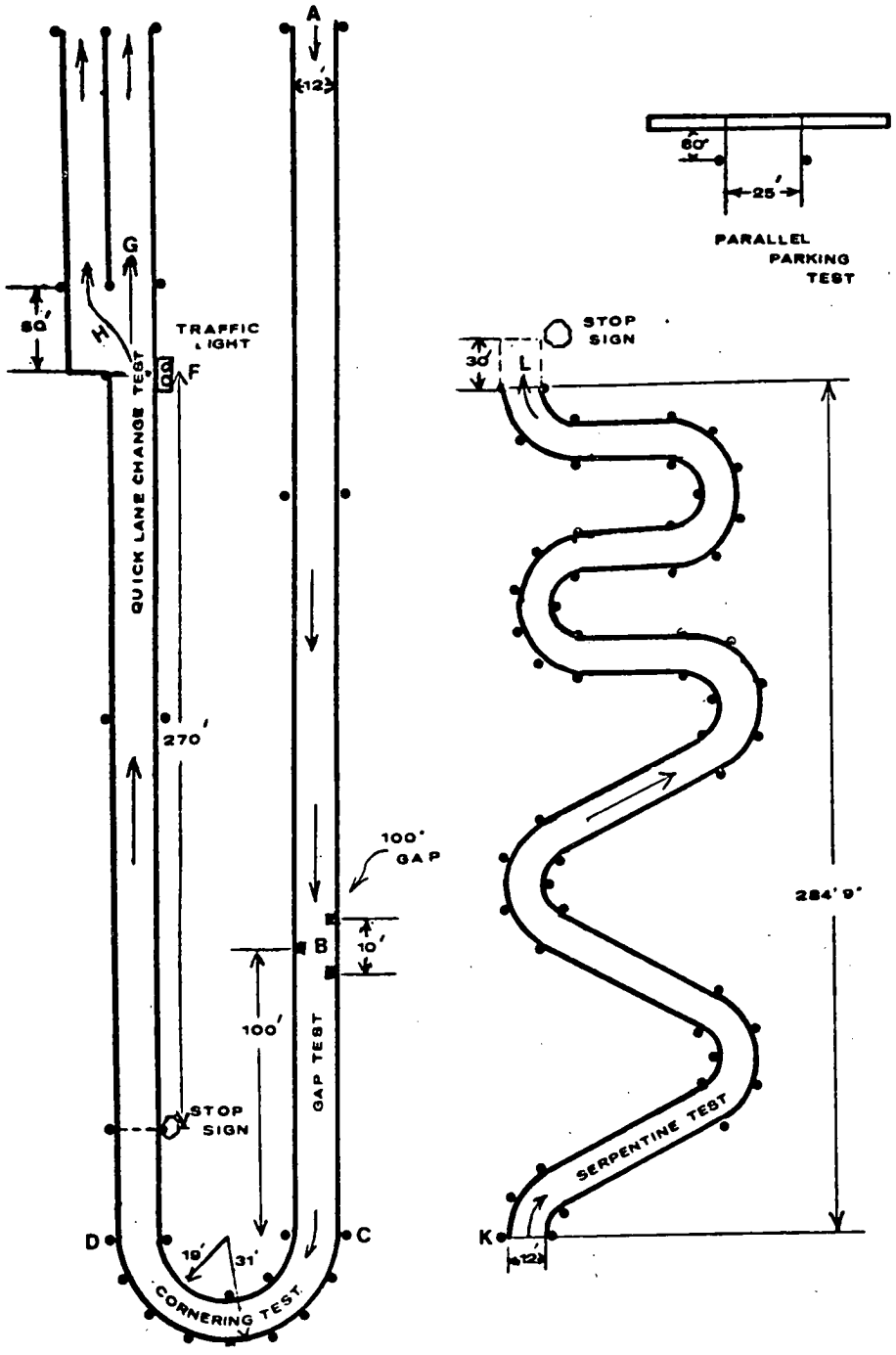


Figure 2. Cornering test results for novices before driver education.

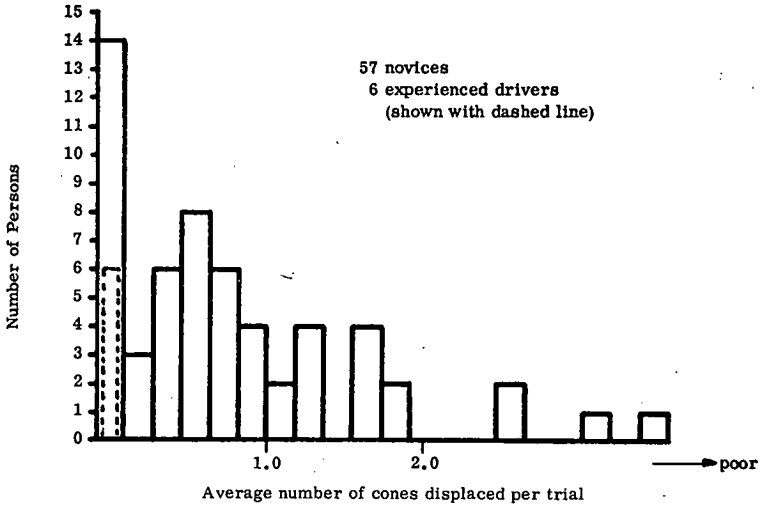
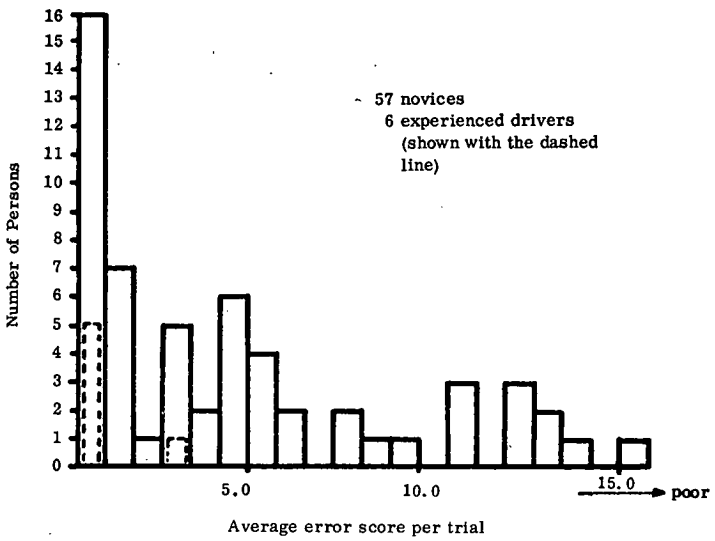


Figure 3. Quick lane-change test results.

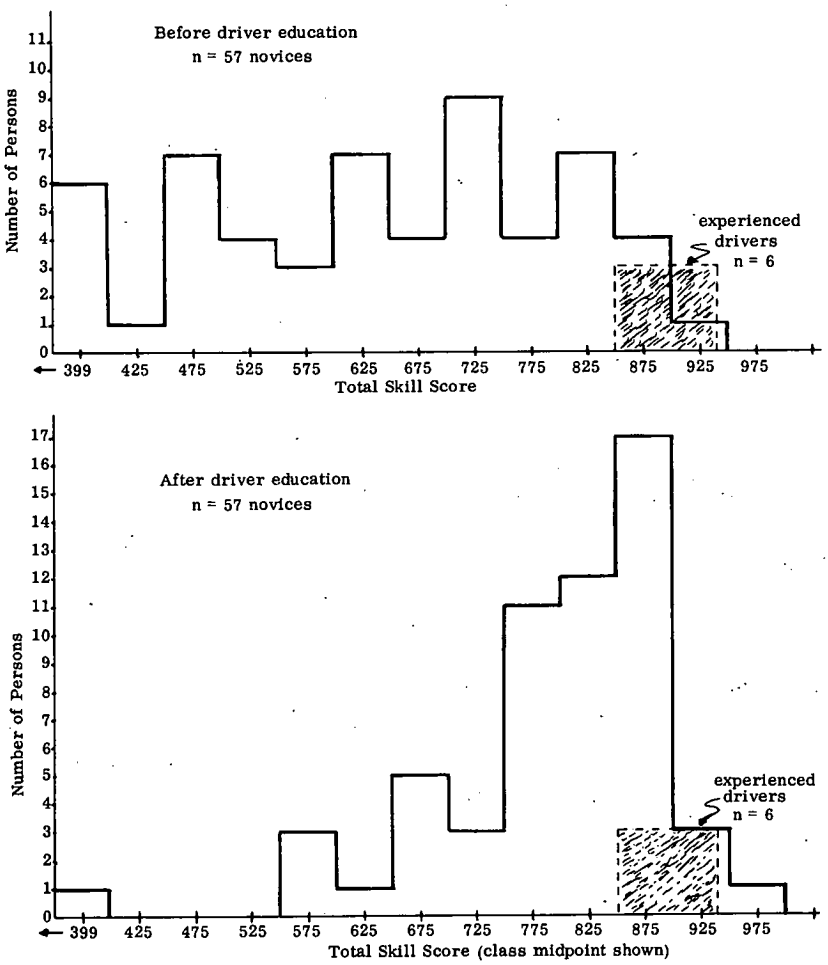


interesting to examine individually, analysis of each measure separetely is somewhat cumbersome. Although each test measures specific skills, all tests measure different aspects of general driving skill. For ease of analysis and interpretation of changes in driver skill, we combined the individual test scores into a single index of driving skill, the total-skill score. The method used to combine the test scores was to add them after an appropriate scaling and relative importance rating were applied to each score.

The distribution of the total-skill scores is shown in Figure 4. Note that, like the individual test scores, the total-skill score shows a wide range of performance ability before driver education and much poorer performance by most novices than by experienced drivers.

Upon completion of driver education, most novices showed great improvements in performance. Many students approached the levels of skill exhibited by experienced drivers (Fig. 4). Strikingly, however, almost half the students still performed well

Figure 4. Total-skill scores before and after driver education.



below the level of skill of the experienced drivers after completion of driver education.

The students were tested again 1 year after completing driver education (Fig. 5). Most of the students attained the skill level demonstrated by experienced drivers, but about 15 percent were still below the level of experienced drivers.

In addition to exhibiting a wide range of skill scores on the tests before driver education, novices exhibited a wide range of improvements in scores after driver education. Furthermore, the amount of skill improvement after the course was highly correlated with the score before driver education ($r = -0.66$, $\alpha < 0.05$). That is, students who scored very poorly before driver education improved greatly, whereas students who scored very well before the course improved little. The students were divided into three groups based on the total-skill score before driver education; the top group was the high skill group. The average performance for each of these groups on the total-skill score is shown in Figure 6.

This figure shows clearly that the low performers improved the most after driver education. In spite of this improvement, however, the skill level of the lowest group after driver education was not at the skill level of the highest performers before driver education ($\alpha = 0.05$).

Further analysis of the data revealed an interesting profile of driving exposure time for the initially low performers. The low group appeared to receive less driving exposure than the middle and high performers (Table 2). The initially low group tended

Figure 5. Total-skill scores 1 year after driver education.

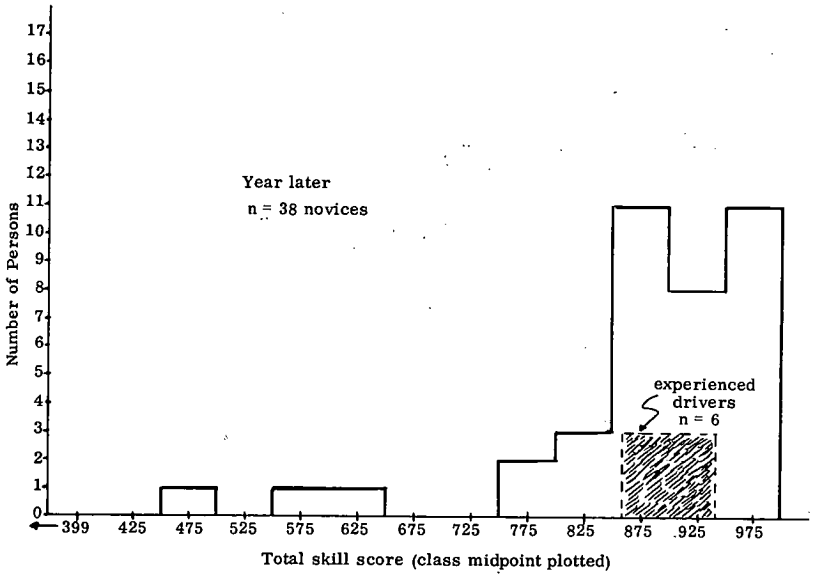


Figure 6. Total-skill scores for each group.

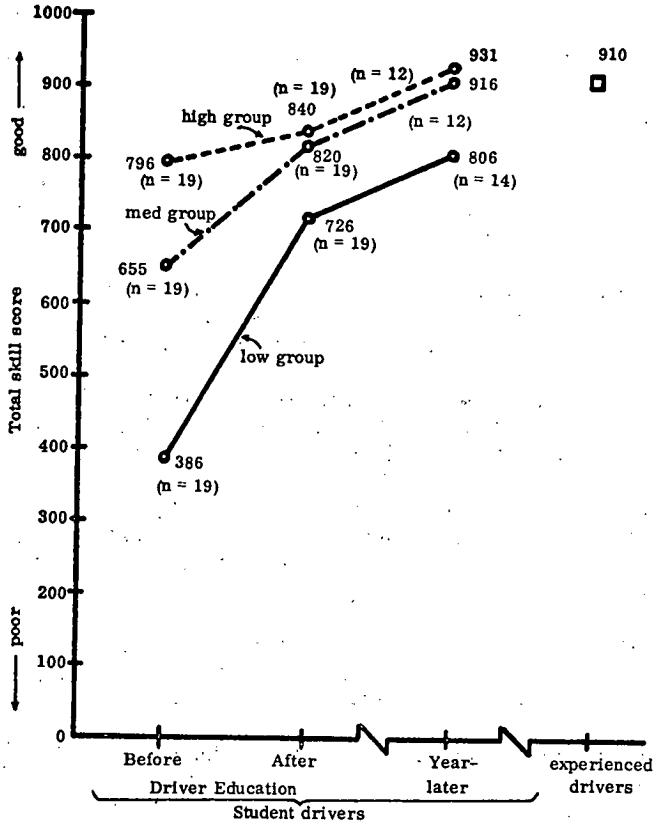


Table 2. Driving exposure of student drivers.

Student Data	Student Skill Groups		
	Low	Medium	High
Average hours of informal driving before driver education	2.2	3.8	14.7
Persons reporting more than 5 hours of informal driving during driver education	6 of 19	12 of 19	14 of 19
Persons driving daily after driver education	4 of 12	10 of 12	14 of 14
Average hours of driving under instructor supervision	4.7	6.1	7.1

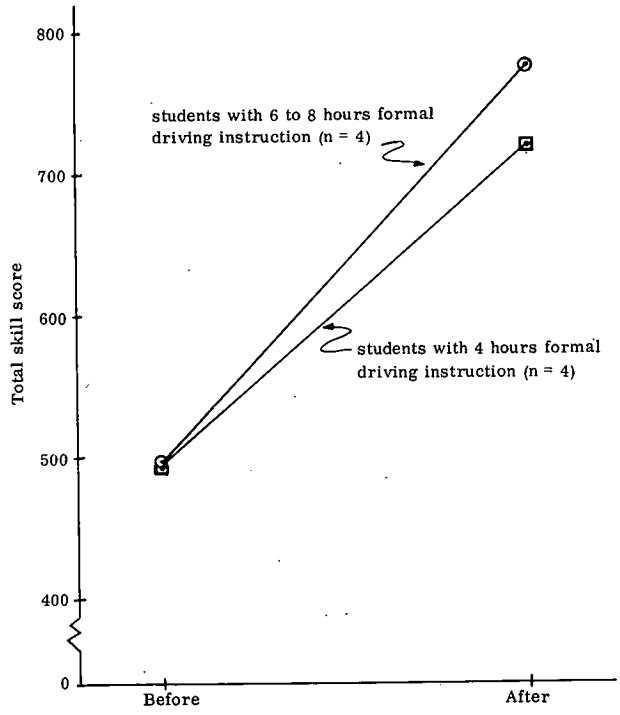
Note: n = 19 for each skill group.

to drive fewer hours informally before entering driver education; they drove fewer hours outside the classroom with informal instruction; they received fewer hours of formal instruction; and they drove less within the first year after completing driver education. Unfortunately, the persons who needed extra practice the most received it the least.

As is shown in Figure 6, the lowest initial performers have much room for improvement after completion of driver education. It seems reasonable to suspect that those students who receive more time behind the wheel attain higher levels of skill. The data for the lowest third were examined for the possible effect of the number of hours of formal instruction behind the wheel. To analyze the effect of the number of formal hours, we classed the students in two groups: those with few formal hours (4 hours) and those with high formal hours (6 or 8 hours). Of these, only students with similar initial skill levels were included in the comparison (earlier results have shown that skill improvement is largely determined by initial skill level). Only four students within each group could be matched in initial skill level. Though the results shown in Figure 7 are not statistically significant, the trend in the data suggests that more formal hours of instruction may result in higher skill levels. Of course, the strength of this conclusion must be tempered by the small sample sizes available.

A separate study with fewer subjects (12 novices and 6 experienced drivers) was conducted after the main study. Although the primary purpose of this study was to develop tests of safe driving practices (6), the range skill tests were also administered

Figure 7. Effect of formal driving on skill.



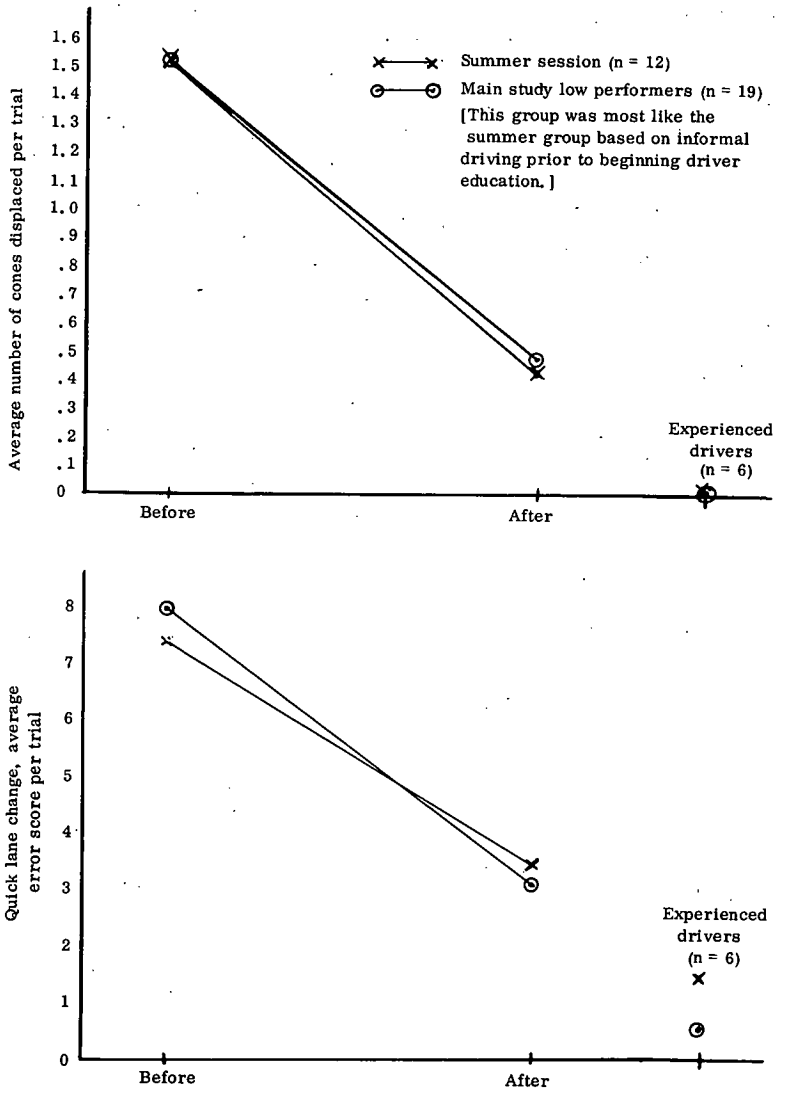
to these subjects. The range tests yielded extremely reliable results from two studies with different subjects, different setups, different experimenters, and different cars (Fig. 8).

CASE FOR DIAGNOSTICS

Novice drivers exhibited a wide range of skill levels before entering driver education. Students who entered driver education with high skill levels had little room for improvement but were relatively near the skill level of experienced drivers. Poor initial performers, on the other hand, improved greatly during driver education, but, by the completion of the course, they still had not attained the level of skill exhibited by high performers before driver education. Thus, the results suggest that some students need more training than others to attain higher levels of skill.

A promising application of the tests developed thus appears to be the use of the tests

Figure 8. Comparison of range test scores in separate experiments.



and measures as a diagnostic tool. Upon entering driver education, students can be tested and ranked as high, medium, or low performers. Low performers, who need training beyond the standard program, can be assigned to enriched programs with a greater number of hours of driving time. (The actual number of hours and types of experience required are still a topic for research.) If limited budgets prohibit enriched programs, perhaps giving more training to the poor performers and less to the high performers will result in more effective use of existing driver education resources.

SUMMARY

The main objective of this phase of the research project was to develop objective tests of student driving performance. The tests developed proved sensitive to students' levels of driving performance before entering driver education and to changes in performance after driver education. The results of the tests showed that students bring widely varying levels of skill to the driver education program. Furthermore, the results indicated that some students need additional training to attain requisite high levels of skill. The performance tests developed in this study can be used as a diagnostic tool to identify student needs. With such a diagnostic approach, programs can be matched to students' needs.

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