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A STUDY WITH REPLICATION OF TRANSFER AMONG PSYCHOMOTOR TASKS IN AGRICULTURAL POWER

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Skill in single-cylinder agricultural gasoline engine overhaul is a prerequisite for many students who enter the field of agricultural mechanization. Realizing this need, comprehensive high schools, vocational-technical schools, and many colleges are offering instruction in small gasoline engines as a prerequisite for students wishing to advance to multicylinder agricultural gasoline engine overhaul instruction. Much of the rationale for the teaching of single-cylinder agricultural gasoline engine overhaul is based on the assumption that the knowledge will transfer to multicylinder gasoline engine overhaul. However, there is a lack of adequate research to substantiate the rationale. Number limitations, lack of experimental controls, and practitioner usability were identified by Govatos (1967) as three reasons why motor-skill learning studies do not provide valid information which practitioners may later use.

This study was organized to compare the effects of three types of laboratory instruction on transfer of learning from a single-cylinder agricultural engine to a multicylinder agricultural engine in the area of carburetion. More specifically, the study attempted to answer the following questions:

1. To what extent is transfer affected by varying the type of laboratory instruction?
2. To what extent is the length of time required for completion of the transfer task affected by the type of laboratory instruction?
3. To what extent are there performance differences among the specific subtasks analyzed?
4. To what extent do different types of laboratory instruction quality scores correlate with completion time of the transfer task?

Methodology

A three-group controlled experiment with a replication was conducted using a posttest-only control group experimental design. The design was an expansion of the posttest-only control group experimental design described by Stanley and Campbell as found in Gage (1963: 193). To prevent confounding of the treatment effects, there was no pretest administered to the treatment groups. The participants were randomly assigned to the three treatment groups with as nearly equal numbers as possible.

The experimental study with replication was selected to eliminate possible confounding variables associated with conducting the study in multiple locations. The design attempted to eliminate the grouping of data from students taught in different facilities, students having different educational experiences, and students reared in rural and urban communities. This necessitated that the data analysis be handled as an experimental study and as a replication, rather than by combining the data from all locations. To provide a contrast between the location differences, a comparison of the responses of students in the experimental study with those from the replication was computed. A pilot study was conducted prior to the experiment.

Procedures. The transfer task selected for this study dealt with the disassembly, inspection of parts, and assembly of a Zenith Model 61 carburetor. The researcher, with the aid of a panel of experts, prepared the necessary materials to conduct the experiment. The transfer task was identical for all subjects and was presented to the treatment groups in a five stage sequence as follows: (1) review of carburetion, (2) laboratory instruction, (3) disassembly, (4) inspection of parts, and (5) assembly.

The students were divided into three laboratory sections and directed by an experienced agricultural mechanics instructor. Group A received no laboratory instruction before performing the transfer task. Group B received hands-on laboratory instruction with the aid of a slide-tape presentation utilizing single-cylinder flow jet, agricultural-type, engine carburetors. Group C received hands-on laboratory instruction with the aid of a slide-tape presentation utilizing multicylinder, agricultural-type, gasoline engine carburetors (Zenith Model 61). Treatment groups B and C were provided with tools, carburetors, projectors, slides, screens, cassettes, and recorders.

Sources of Data. The population of this experiment consisted of the high school students enrolled in agricultural power mechanics during the 1976-1977 school year within a fifty mile radius of Columbia, Missouri. The experiment was conducted in the vocational agriculture department over a one-week period using 35 students in three sections of agricultural power mechanics at Hickman High School in Columbia, Missouri, and replicated with 29 students in two randomly selected schools, Macon County R-1 and Vandalia-Farber. All students had successfully completed an instructional sequence on small gasoline engines prior to the study. The students were screened and two individuals who could have biased the results due to prior hands-on experience were eliminated.

One measure used in the study was a quality score from each student, determined through the use of an objective scale and recordéd by the researcher. The other measure was that of completion time, recorded for each applicant as the disassenbly and assembly subtasks were completed.

Statistical Procedures. Null hypotheses were formulated for the study and were analyzed using a one-way analysis of variance or a Pearson Product Moment Correlation. When a significant difference was found by using the analysis of variance, a Newman-Keuls Sequential Range Test was calculated to isolate the source of the difference. An independent t-test was calculated to determine if the correlations were significant. The hypotheses were tested at an alpha level of .05. An independent t-test was calculated to compare the data from the study and the replication.

Findings and Conclusions

Hypothesis Ho_1, there is no significant difference among the three treatment groups on mean quality scores, was not rejected. Performance on the transfer task by the three treatment groups was not significantly different for the experimental study. Consistent results were found for the replication. The mean transfer quality scores and the calculated F values for both the study and the replication are reported in Table 1.

Table 1

MEAN QUALITY SCORES AND COMPLETION TIMES BY GROUPS FOR THE TRANSFER TASK

	Treatment Group	No Lab Experience A	Small Engine Lab B	Large Engine Lab C	Obtained F
Quality Scores	Exper. Study	67.00	68.58	71.82	1.09
	Replication	73.80	71.44	74.20	.88
Completion Times	Exper. Study	54.03	47.34	41.25	3.56*
	Replication	55.25	53.68	39.52	3.09

*Significant at the .05 level.

Hypothesis Ho_2, there is no difference among the three treatment groups on mean completion times, was rejected. The time required for completion of the transfer task was significantly different for the three treatment groups in the experimental study. The analysis indicated the students in Group C differed on time for completion from students in Group A. The laboratory practice utilizing large gasoline, agricultural-type, engine carburetors aided treatment Group C in completing the transfer task in less time. A within-group variance of 53.7 minutes prevented a significant difference in the replication. Therefore, null hypothesis Ho_2 for the replication was not rejected. The mean completion times and the calculated F values for both the study and replication are reported in Table 1.

Hypothesis Ho_3, there is no significant difference among the three treatment groups on the mean quality scores on the three transfer subtasks (disassembly, inspection, and assembly), was not rejected for the disassembly and inspection of parts subtasks. Hypothesis Ho_3 was rejected for the assembly subtask for the experimental study. Performance on the disassembly and inspection of parts subtasks by the three treatment groups was not significantly different. However, the statistical comparison of the assembly subtask quality scores for the treatment groups showed that the students in Group C earned a higher quality score than the students in Group A of the experimental study. The statistical comparison for hypothesis Ho_3 for the replication found no significant difference among the three treatment groups on the mean quality scores for the three transfer subtasks analyzed. The mean quality scores and the calculated F values for the three treatment groups on the transfer subtasks are reported in Table 2.

Table 2

MEAN QUALITY SCORES BY GROUPS FOR THE THREE TRANSFER SUBTASKS

Study	Subtask Scores	Treatment Groups: No Experience A	Treatment Groups: Small Engine Lab B	Treatment Groups: Large Engine Lab C	F
Exper. Study	Disassembly	24.92	24.50	24.73	.08
	Inspection	21.42	21.00	21.09	.10
	Assembly	20.67	23.08	26.00	3.65*
Replication	Disassembly	25.80	25.33	27.00	1.94
	Inspection	20.80	20.56	20.40	.08
	Assembly	27.20	25.56	26.80	.56

*Significant at the .05 level.

Hypothesis Ho_4, there is no significant correlation between quality scores and completion time for the treatment groups, was rejected for treatment Group A of the study. Hypothesis Ho_4 was not rejected for treatment Groups B and C of the experimental study. The statistical comparison of quality scores with completion times revealed a significant negative correlation for treatment Group A. The students in treatment Group A did not improve their scores by taking longer amounts of time to complete the transfer task. Comparisons for treatment Groups B and C did not reveal significant correlations. The statistical comparisons for Ho_4 by treatment groups found no significant correlations for the replication.

To help ascertain the generalizability of the study to central Missouri schools, treatment Groups A, B, and C of the experimental study were compared with their counterpart treatment groups of the replication. Fifteen comparisons were tested statistically. Two significant differences were found within Group A: one on total quality scores and another on the assembly subtasks. The third difference was found within Group C on the disassembly subtask. The replication students were found to have received higher quality scores on each of the significant comparisons.

The following conclusions were based upon the findings of this experimental study:

> The "no" laboratory and small engine laboratory treatment groups demonstrated transfer on the task for both the study and the replication.
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> There was transfer for the "no" laboratory and small engine laboratory treatment groups for the disassembly and inspection of parts subtasks for the experimental study replication. In addition, these two treatment groups from the replication also demonstrated transfer on the assembly subtask.
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> Laboratory instruction utilizing equipment like that used for the performance of the transfer task was the most time-efficient way of teaching. Using larger amounts of time for completion of the transfer task would not improve the score of students who have not recently had laboratory experience on either small or large gasoline engines.

Discussion

The findings of the statistical comparisons for the transfer task warranted additional discussion to evaluate the transfer that existed within the study. By comparing the means of the subtasks of the transfer task, more information about the transfer was found. Transfer from Groups A and B to the transfer subtasks of disassembly and inspection of parts was found in the experimental study. The transfer was found between Group B and the subtask only for the assembly subtask. There was a significant difference between Groups A and C for the assembly subtask. The actual performance of the transfer task aided Group C in receiving a higher quality score. The replication found transfer between Groups A and B to the transfer task for all three subtasks.

In evaluating the relationship of scores with completion times, a trend appears to be evident. The scores of the students in Groups B and C approached a positive correlation with completion time for the experimental study. Similar findings occurred with the replication. This indicated that Group A would not increase quality scores just by using more time to complete the task. The trend was in the opposite direction for Group C. There was no consistent correlation for Group B. Due to the small numbers involved in this study, further research is suggested.

Fifteen independent t tests were computed to compare the data analyzed in the study on the basis of locations of which three comparisons were found to be significant. There was a difference between the two A Groups (those who had no laboratory experience) on total quality scores of the transfer task. A significant difference was also found between the two locations on the assembly subtask. This subtask difference was probably the reason the first significant difference was found between the two treatment C Groups for the disassembly subtask. The students in the replication received higher quality scores. These three differences probably can be explained by the fact that students in the replicated study had an advantage from past experiences. The three differences found by the independent t-test comparison did not appear to justify a conclusion that students in the two locations were different.

Recommendations

The following recommendations are made:

1. The results of the experiment and replication for three methods of laboratory instruction were consistent in terms of quality scores suggesting transfer. There was not conclusive evidence from this study to suggest that vocational agriculture teachers should alter their method of instruction in agricultural power courses.

2. The method of instruction was found to affect the time required for completion of the transfer task. There-

fore, those instructors of agricultural power courses who are concerned with completion times should provide laboratory experiences using the actual equipment rather than no equipment or small scale equipment.

3. Major differences between students in a city school and schools in outstate Missouri were not found to exist. Therefore, the same instructional approach can be suggested for use in both types of schools in central Missouri in the teaching of agricultural power.

4. Inasmuch as transfer was found for both experimental methods of laboratory instruction (no recent experience or small engine experience), it is justifiable to assume that there will be transfer from small gasoline engines. Teachers can justify offering small gasoline engines classes based in part on the fact that skills learned will transfer to situations requiring skills related to large gasoline engines.

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McCracken--continued from page 10

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