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Comparative Effects of Cooperative and Problem-Based Teaching Methods on Students' Psychomotor Skills in Motor Vehicle Mechanics Works in Technical Colleges in Akwa Ibom State, Nigeria

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Abstract

This study compared the effects of cooperative and problem-based teaching methods on students' psychomotor skills performance in Motor Vehicle Mechanics Works in technical colleges in Akwa Ibom State, Nigeria. A quasi-experimental pre-test–post-test design involving two non-randomized intact classes was adopted. The population comprised Senior Technical Two students offering Motor Vehicle Mechanics Works in the nine state-owned technical colleges, while 68 students from two selected colleges participated in the study. Fifty students were taught with the cooperative teaching method and 18 students with the problem-based teaching method for five weeks. Data were collected using the 50-item Motor Vehicle Mechanics Works Psychomotor Rating Scale, which yielded a test–retest reliability coefficient of 0.88. Mean and standard deviation were used to answer the research questions, while analysis of covariance was used to test the hypotheses at the 0.05 level of significance. Both methods improved performance across engine oil servicing, cooling-system flushing, distributor and spark-plug cable testing, injector servicing, and automobile-battery testing. Cooperative teaching produced higher mean gains in all five skill areas. Significant differences were found for cooling-system flushing and automobile-battery testing, whereas differences in engine oil servicing, ignition-cable testing, and injector servicing were not statistically significant. The study concludes that cooperative teaching is generally more effective for practical Motor Vehicle Mechanics Works instruction and recommends its structured integration with problem-based and demonstration methods.

Keywords: cooperative teaching, problem-based teaching, psychomotor skills, motor vehicle mechanics, technical colleges, Akwa Ibom State.

1. Introduction

Motor Vehicle Mechanics Works is a major technical trade offered in Nigerian technical colleges and is central to the national policy emphasis on vocational and technical competence [11, 1]. It equips learners with the knowledge and practical competence required to diagnose, service, maintain and repair vehicle systems. The effectiveness of the programme depends not only on workshop facilities and curriculum content but also on the instructional methods used by teachers. In many technical colleges, lecture and demonstration remain dominant, even though these methods can place students in relatively passive roles and may not adequately support repeated practice, peer interaction, problem solving and transfer of learning [8, 10].

Cooperative teaching organizes learners into small, heterogeneous groups in which members work toward shared learning goals and are jointly accountable for performance [13, 19]. Its essential features include positive interdependence, face-to-face interaction, individual accountability, interpersonal skills and group processing. These features are particularly relevant to workshop instruction, where students must observe procedures, handle tools, discuss faults, provide feedback and perform tasks safely; empirical studies have also reported benefits of cooperative learning in motor vehicle technology and other practical subjects [9, 16].

Problem-based teaching, on the other hand, begins with an authentic or simulated problem that learners investigate and solve [14]. The teacher acts mainly as a facilitator while students identify what they know, determine what they need to learn, propose solutions and test procedures. In automobile technology, this method is valuable because maintenance and repair activities frequently involve diagnosis, decision making and application of knowledge to real faults [12, 17]. Research in science and technical education has similarly shown that problem-based and project-oriented approaches can improve achievement and skills acquisition [3, 2, 7, 4].

Psychomotor performance refers to the coordinated application of perceptual, cognitive and muscular processes in the execution of practical tasks [15, 18]. In Motor Vehicle Mechanics Works, such performance includes correct tool selection, procedural accuracy, safety consciousness, speed, coordination and the quality of the completed task. The present study therefore compared cooperative and problem-based teaching methods in five practical areas: engine oil servicing, flushing of a water-cooling system, testing distributor and spark-plug cables, servicing injectors and testing an automobile battery.

1.1. Purpose of the Study

The study determined the comparative effects of cooperative and problem-based teaching methods on students' psychomotor skills performance in Motor Vehicle Mechanics Works in technical colleges in Akwa Ibom State. Specifically, it compared students' performance in the five practical tasks listed above.

1.2. Research Hypotheses

Five null hypotheses stated that no significant mean difference existed between students taught with cooperative and problem-based methods in each of the five practical skill areas. All hypotheses were tested at the 0.05 significance level.

2. Theoretical and Conceptual Framework

The study was anchored principally on social constructivism, social learning theory, psychomotor-domain theory and discovery learning. Social constructivism explains learning as a socially mediated process in which knowledge is developed through interaction, dialogue and guided participation [20]. This supports cooperative teaching because students share ideas, observe one another, receive assistance and gradually assume responsibility for group performance.

Social learning theory emphasizes observation, modelling, retention, reproduction and motivation [5]. In practical automobile instruction, students learn by watching a competent demonstration and then reproducing the procedure under supervision. Peer modelling within cooperative groups can therefore strengthen skill acquisition.

Psychomotor-domain theory describes the progression from perception and readiness through guided response, mechanism, complex overt response, adaptation and origination. The theory supports deliberate sequencing of practical tasks from observation and assisted practice to independent and adaptive performance. Discovery learning further supports problem-based teaching by emphasizing inquiry, exploration, manipulation of materials and the learner's active role in deriving solutions [6].

Taken together, these perspectives suggest that psychomotor learning is strengthened when students receive modelling and guidance, practise repeatedly, interact with peers, solve authentic problems and receive timely feedback.

3. Methodology

3.1. Research Design and Area

A quasi-experimental pre-test–post-test design with two non-randomized intact groups was used. The study was conducted in Akwa Ibom State, Nigeria, which has nine public technical colleges distributed across its three senatorial districts.

3.2. Population, Sample and Sampling

The population comprised Senior Technical Two students offering Motor Vehicle Mechanics Works in the nine state-owned technical colleges during the 2023/2024 academic session. A sample of 68 students was drawn from two intact classes in two purposively selected colleges. One class of 50 students was assigned to the cooperative-teaching group, while one class of 18 students formed the problem-based-teaching group.

3.3. Instrument

Data were collected with the researcher-developed Motor Vehicle Mechanics Works Psychomotor Rating Scale. The instrument contained 50 tasks rated on a five-point scale and covered engine oil servicing, cooling-system flushing, distributor and spark-plug cable testing, injector servicing, and electrolyte and voltage testing of an automobile battery. Three experts validated the instrument. A test–retest procedure with 20 students outside the main sample produced a Pearson correlation reliability coefficient of 0.88.

3.4. Experimental Procedure and Data Analysis

Both groups completed a pre-test before treatment. The cooperative group was taught with structured cooperative lesson plans, while the second group was taught with problem-based lesson plans. Treatment lasted five weeks during normal class periods. Students then completed practical post-tests in the school workshops and were rated with the same instrument. Mean and standard deviation answered the research questions, while analysis of covariance (ANCOVA), using pre-test scores as covariates, tested the hypotheses at $\alpha = 0.05$.

4. Results

Table 1 summarizes the pre-test, post-test and gain scores. Cooperative teaching produced higher gain scores in all five skill areas.

The gain advantage for cooperative teaching was 1.81 points for engine oil servicing, 2.02 points for cooling-system flushing, 0.93 points for distributor and spark-plug cable testing, 1.28 points for injector servicing and 1.25 points for automobile-battery testing.

The ANCOVA results in Table 2 show statistically significant teaching-method effects for cooling-system flushing and automobile-battery testing. The effects for engine oil servicing, distributor and spark-plug cable testing, and injector servicing were not statistically significant.

4.1. Graphical Analysis of Performance

Figures 1, 2 and 3 provide a visual interpretation of the descriptive and inferential results. Figure 1 compares post-test mean scores. The two methods produced relatively high scores in

Table 1: Pre-test, post-test and mean-gain scores by teaching method

Skill area	Method	N	Pre-test $\bar{x}$	Pre SD	Post-test $\bar{x}$	Post SD	Gain
Engine oil servicing	Cooperative	50	33.36	5.85	46.28	3.52	12.92
	Problem-based	18	34.00	3.56	45.11	2.39	11.11
Cooling-system flushing	Cooperative	50	32.00	5.87	44.80	3.05	12.80
	Problem-based	18	32.00	3.88	42.78	1.83	10.78
Distributor/spark-plug cables	Cooperative	50	31.30	5.12	44.00	2.94	12.70
	Problem-based	18	30.67	3.29	42.44	5.20	11.77
Injector servicing	Cooperative	50	32.56	3.92	45.84	5.29	13.28
	Problem-based	18	34.22	2.98	46.22	3.69	12.00
Automobile-battery testing	Cooperative	50	30.80	5.31	45.60	3.13	14.80
	Problem-based	18	28.67	6.79	42.22	2.16	13.55

Table 2: ANCOVA results for the effect of teaching method

Skill area	F	p	Decision on H_0	Interpretation
Engine oil servicing	1.62	0.208	Retained	Not significant
Cooling-system flushing	6.86	0.011	Rejected	Significant
Distributor/spark-plug cables	2.29	0.135	Retained	Not significant
Injector servicing	0.03	0.953	Retained	Not significant
Automobile-battery testing	15.77	< 0.001	Rejected	Significant

all five tasks, but the cooperative group recorded higher post-test means in four areas. Injector servicing was the only task in which the problem-based group had a slightly higher raw post-test mean (46.22 versus 45.84). This small difference should be interpreted alongside the ANCOVA result, which showed no significant method effect for injector servicing.

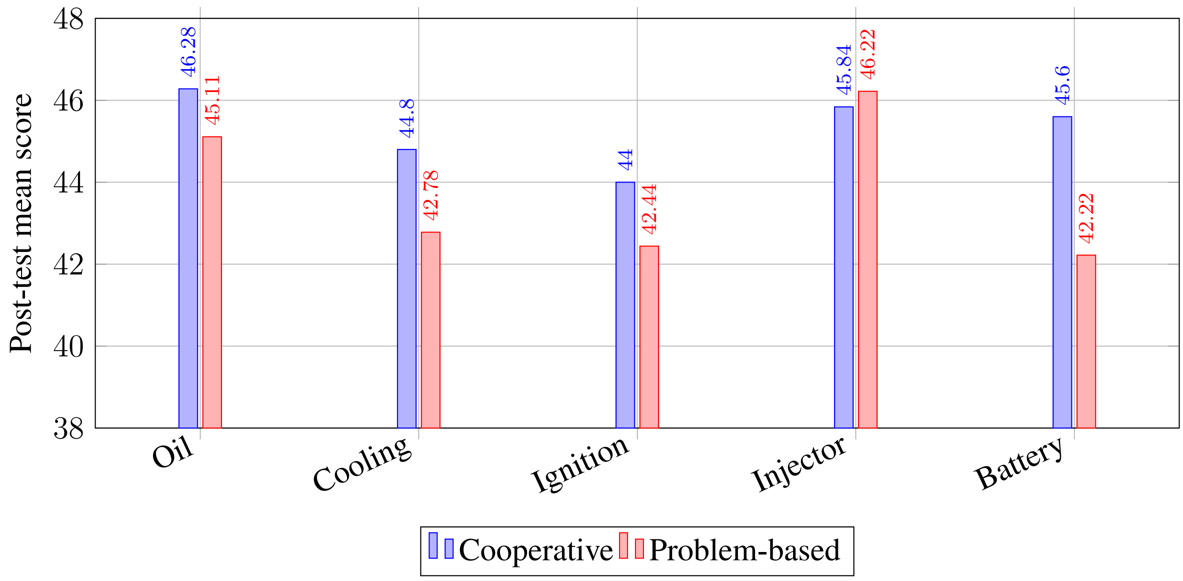

Figure 1: Comparison of post-test mean scores across the five psychomotor tasks

Figure 2 focuses on improvement from pre-test to post-test. Cooperative teaching produced larger mean gains in every skill area. The largest cooperative gain occurred in automobile-battery testing (14.80), followed by injector servicing (13.28). For the problem-based group, automobile-battery testing also produced the largest gain (13.55). The greatest advantage of cooperative teaching over problem-based teaching occurred in cooling-system flushing, where the difference in mean gain was 2.02 points.

Figure 3 presents the ANCOVA probability values together with the 0.05 significance threshold. Cooling-system flushing ($p = 0.011$) and automobile-battery testing ($p < 0.001$) fall below the threshold and therefore indicate significant differences between the methods. The remaining tasks have probability values above 0.05 and do not provide sufficient evidence of a statistically significant method effect.

Overall, the graphical evidence confirms a consistent descriptive advantage for cooperative teaching, while the inferential evidence shows that this advantage reached statistical significance only for cooling-system flushing and automobile-battery testing. The plots therefore distinguish practical improvement from statistical significance and prevent the higher raw means from being interpreted as significant in every task.

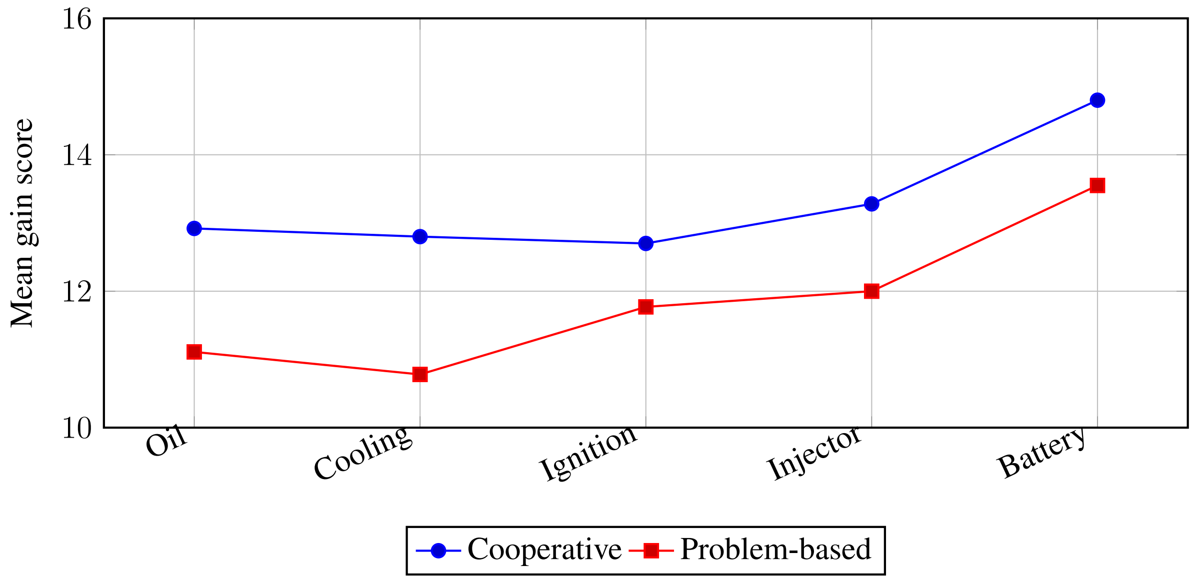

Figure 2: Mean gain scores for cooperative and problem-based teaching methods

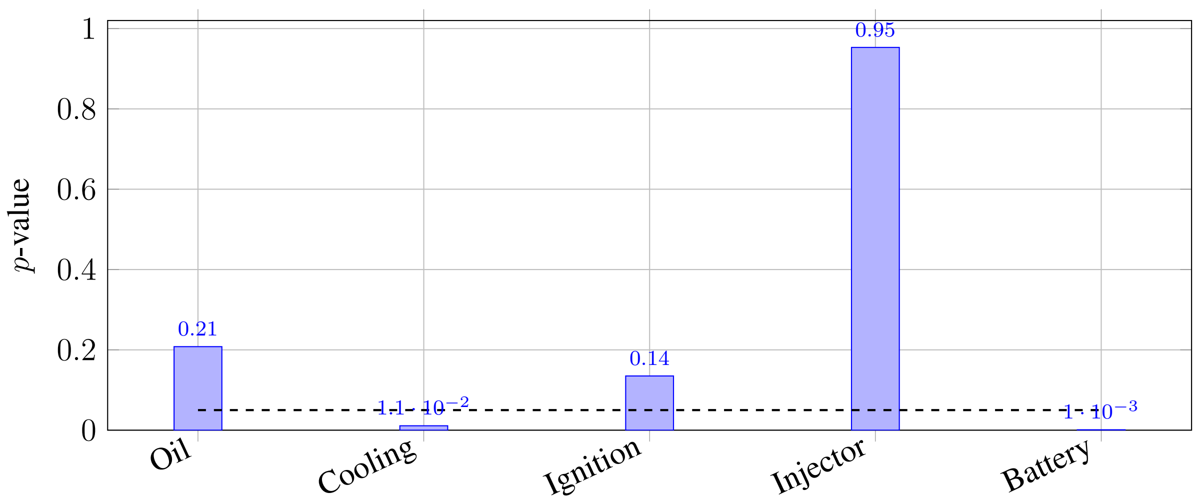

Figure 3: ANCOVA probability values by skill area; the dashed line represents $\alpha = 0.05$. The battery value is plotted as 0.001 because the reported result was $p < 0.001$.

5. Discussion

Both cooperative and problem-based teaching methods improved students' psychomotor performance, as reflected in the positive mean gains across all five tasks. This general improvement is consistent with learner-centred theories that emphasize active engagement, authentic practice and continuous feedback [6, 20, 5].

The cooperative group nevertheless recorded higher gain scores in every task. Group work likely increased opportunities for observation, peer correction, verbalization of procedures and repeated practice. Positive interdependence may also have motivated stronger students to support peers while retaining individual responsibility for task completion. These characteristics are especially useful in workshop environments where equipment is limited and students must rotate through practical stations, and they agree with previous findings on cooperative learning in technical and science education [9, 16, 19].

The significant advantage of cooperative teaching in cooling-system flushing may be explained by the sequential and collaborative nature of the task. Students must identify components, prepare tools, drain and flush the system, observe safety precautions and verify completion. The significant result for battery testing similarly suggests that peer interaction supports correct instrument connection, reading interpretation and safety checks.

The absence of significant differences in engine oil servicing, ignition-cable testing and injector servicing does not imply that the methods were ineffective. Rather, it indicates that both approaches produced broadly comparable adjusted post-test outcomes in those areas. Problem-based teaching may be particularly useful where diagnosis and independent reasoning are central, while cooperative teaching may be stronger where tasks benefit from coordinated roles and peer modelling [14, 3, 2, 7].

The unequal group sizes and use of intact classes should be considered when interpreting the findings. Although ANCOVA adjusted for pre-test differences, random assignment of individual students was not possible. The study was also limited to two colleges and five practical tasks.

6. Conclusion

Cooperative and problem-based teaching methods both enhanced students' psychomotor performance in Motor Vehicle Mechanics Works. Cooperative teaching generated higher mean gains across all five practical areas and produced statistically significant advantages in cooling-system flushing and automobile-battery testing. The evidence therefore supports cooperative teaching as a particularly effective strategy for practical automobile instruction, while problem-based teaching remains a valuable complementary method for developing diagnosis, inquiry and independent problem-solving skills.

7. Recommendations

1. Teachers should integrate structured cooperative learning into practical Motor Vehicle Mechanics Works lessons, particularly for tasks requiring sequential procedures, shared tools and peer observation.

2. Problem-based teaching should be retained and combined with cooperative and demonstration methods for fault diagnosis and open-ended workshop activities.

3. The Akwa Ibom State Ministry of Education and the State Technical Schools Board should organize retraining programmes on learner-centred workshop pedagogy.

4. Technical-college principals should support lesson planning, workshop scheduling and assessment practices that permit active group participation and individual accountability.

5. Further studies should use larger samples, more colleges, balanced groups and delayed retention tests.

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Conflict of Interest

The author declares no conflict of interest.

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