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EFFECTIVENESS OF SKILLS ENHANCEMENT FRAMEWORK IN IMPROVING PRACTICAL COMPETENCE AND ACHIEVEMENT OF MOTOR VEHICLE MECHANICS STUDENTS IN BENUE STATE

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ABSTRACT

This study developed and evaluated a Skills Enhancement Framework (SEFW) to improve the practical competence and achievement of Motor Vehicle Mechanics Work (MVMW) Students in Science and Technical Colleges (STCs) in Benue State, Nigeria. Two research questions were raised and two null hypotheses tested at 0.05 level of significance. The study adopted a Research and Development design combining a quasi-experimental pretest–posttest non-equivalent control-group approach. A census sampling technique was used to draw 74 respondents (58 experimental, 16 control) from MVMW students in Science and Technical Colleges in Benue State offering the trade. Data were collected using a 30-item Practical Skills Competencies on Modern Motor Vehicle System Maintenance (PSCMMVSM) checklist and a 30-item multiple-choice Achievement Test. Research questions were answered using mean and standard deviation, while hypotheses were tested using ANCOVA. The SEFW, implemented over eight weeks, produced significantly higher posttest practical competence and achievement scores in the experimental group than in the control group. The study concludes that the existing STC curriculum is inadequate for current automotive industry demands and recommends adoption of the SEFW, supported by curriculum reform, instructor development, modern equipment and formal school–industry partnerships.

Keywords: achievement, motor vehicle mechanics, practical competence, skills enhancement framework, technical colleges, vehicle maintenance.

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Introduction

Technical and Vocational Education and Training (TVET) has an important role in preparing learners for employment, entrepreneurship and participation in economic development. Its effectiveness, however, depends substantially on whether the competencies taught correspond with changing workplace requirements. The International Labour Organization (ILO, 2024) observes that technological and green transitions are changing occupational skill requirements and increasing the importance of reskilling and upskilling. This concern is particularly relevant to automobile technology, where mechanical systems are increasingly integrated with electronics, software and digitally controlled components.

Motor Vehicle Mechanics Work (MVMW) is consequently no longer confined to conventional engine repair, mechanical transmission servicing and basic electrical maintenance. Modern technicians are increasingly expected to interpret diagnostic trouble codes, operate electronic diagnostic equipment, test sensors and actuators, diagnose network faults and understand electric and hybrid vehicle systems. Nigeria's National Board for Technical Education (NBTE, 2025) has similarly recognised the changing requirements of automobile technology through its revised National Technical Certificate curriculum in Automobile Mechanics Works. Earlier NBTE curriculum documentation also identified deficiencies in electrical/electronic knowledge, systematic fault diagnosis, equipment handling and safety as important challenges requiring competency-based responses.

The situation presents a challenge for Science and Technical Colleges in Benue State. A student may understand the theoretical operation of a vehicle system and still be unable to diagnose or repair an actual fault. Practical competence therefore involves more than knowing what a component does; it includes the ability to select appropriate tools, follow a logical diagnostic procedure, perform maintenance safely and produce an acceptable work outcome. Recent Nigerian studies support this position. Onwusa et al. (2024), for example, found that students exposed to competency-based teaching performed better in MVMW practical skills than students in the comparison group. Aireruor et al. (2024) similarly reported positive outcomes associated with project-based and demonstration approaches in motor vehicle mechanics training.

There is also evidence that inadequate facilities remain a barrier to contemporary automotive training. Muoghalu and Ahmad (2026) found facility-related gaps affecting auto-electricity/electronics training in Nigerian technical colleges, highlighting the mismatch between rapidly advancing automobile technology and available training resources. Ogbebor and Osuyi (2024) likewise reported inadequate collaboration between technical colleges and automobile industries and recommended stronger partnerships involving teacher retraining, facilities and students' access to industrial environments.

Taken together, these studies establish that competency-based, project-based and demonstration teaching approaches improve MVMW outcomes in isolation, and that facility and industry-partnership gaps constrain training quality. None of them, however, combines needs assessment, instructional design, implementation and evaluation into a single, integrated, testable framework built specifically around MVMW practice in Benue State. It is this gap, the absence of an integrated, evaluated framework rather than another single-strategy intervention that the present study addresses through the development and empirical testing of the Skills Enhancement Framework (SEFW).

Against this background, the present study developed and evaluated a Skills Enhancement Framework designed specifically around the practical realities of MVMW training in Benue State. The framework was intended to move training from isolated practical exercises towards a

coordinated system in which skills needs, curriculum content, instructional strategies, equipment, industry participation and assessment reinforce one another.

A Skills Enhancement Framework (SEFW) is an organised structure for identifying performance gaps, specifying competencies, providing appropriate learning experiences and evaluating whether the intended competencies have been achieved. In this study, the framework was developed as a practical, four-phase response to identified deficiencies in modern vehicle maintenance skills:

1. Needs Assessment – skills gaps in modern vehicle system maintenance are identified through curriculum review, industry expectations and diagnostic-skill benchmarks, establishing what students currently lack relative to industry requirements.
2. Design – instructional content, demonstration sequences, practice tasks and the assessment instruments (checklist and achievement test) are specified to target the gaps identified in phase one.
3. Implementation – the designed instruction is delivered through demonstration, guided practice, problem-solving and project-based activities, supported by modern diagnostic equipment.
4. Evaluation/Feedback – practical competence and achievement are assessed, and findings are used to refine subsequent iterations of the framework.

The framework draws on the logic of systematic instructional design. ADDIE — Analysis, Design, Development, Implementation and Evaluation — is widely used as a systematic approach to instructional development (Branch, 2009; Molenda, 2003). SEFW shares ADDIE's iterative logic of identifying needs, designing an intervention, implementing it and evaluating outcomes, but differs from it in two respects. First, industry alignment is treated as an explicit sub-step within Needs Assessment rather than assumed, so that skill targets are anchored directly to current automotive-industry expectations rather than to a generic instructional-design analysis. Second, SEFW deliberately collapses ADDIE's separate Development stage into Design, yielding four rather than five phases, in order to keep the framework practical and lean for adoption by resource-constrained Science and Technical Colleges.

Practical competence refers to the ability to apply knowledge, skills and appropriate work procedures to perform an occupational task to an acceptable standard. In MVMW, this includes diagnosing faults, selecting and using tools correctly, dismantling and assembling components, carrying out measurements, interpreting diagnostic information and observing workshop safety. Contemporary automotive maintenance increasingly requires the integration of mechanical and electronic competencies. The current NBTE Automobile Mechanics Works curriculum reflects this shift by incorporating contemporary automobile maintenance competencies. Muoghalu and Ahmad (2026) further demonstrate that inadequate facilities can constrain the development of these competencies in Nigerian technical colleges.

For this reason, the SEFW placed practical activities at the center of instruction. Students were expected not simply to hear about modern systems but to observe procedures, practice them, solve maintenance problems and demonstrate competence through performance assessment.

Achievement represents the extent to which students demonstrate acquired knowledge and understanding following instruction. In technical education, achievement and practical competence are closely related but should not be treated as identical. A student may obtain satisfactory theoretical knowledge without demonstrating equivalent practical performance, while repeated practical activities can also reinforce conceptual understanding. Evidence from Nigerian technical colleges indicates that structured instructional interventions can improve academic outcomes. Eze et al. (2020), for example, reported that students taught auto mechanics through

cognitive apprenticeship achieved better outcomes than students taught through demonstration methods alone. Okotubu (2020) also found that demonstration teaching significantly improved achievement and retention in auto mechanics. These findings support the present framework's combination of demonstration, guided practice, problem-solving and project activities rather than reliance on lecture-based instruction alone.

Statement of the Problem

In recent years, the rapid technological advancement in the automobile industry has significantly transformed the design, operation, and maintenance of modern motor vehicle systems. However, in many Science and Technical Colleges in Benue State, the training of motor vehicle mechanics students still relies heavily on outdated instructional methods and limited exposure to contemporary automotive technologies.

This gap has resulted in graduates who often lack the practical competence and achievement levels required to meet industry demands. Although various instructional strategies have been introduced, there is limited empirical evidence on the effectiveness of structured interventions such as a Skills Enhancement Framework in addressing these deficiencies. Consequently, it remains unclear whether such a framework can significantly improve students' practical competence and achievement in modern motor vehicle system maintenance. This study, therefore, seeks to investigate the effectiveness of the developed Skills Enhancement Framework in enhancing these competencies among motor vehicle mechanics students in Benue State.

Purpose of the Study

The study examined the effectiveness of the developed Skills Enhancement Framework in improving:

1. Students' practical competence in modern vehicle system maintenance in Science and Technical Colleges in Benue State.
2. Students' achievement in modern vehicle system maintenance in Science and Technical Colleges in Benue State.

Research Questions

1. Does the developed Skills Enhancement Framework improve students' practical competence in modern vehicle system maintenance in Science and Technical Colleges in Benue State?
2. Does the developed Skills Enhancement Framework improve students' achievement in modern vehicle system maintenance in Science and Technical Colleges Benue State?

Null Hypotheses

H_o1: The developed Skills Enhancement Framework has no significant effect on students' practical competence in modern vehicle system maintenance in Science and Technical Colleges Benue State.

H_o2: The developed Skills Enhancement Framework has no significant effect on students' achievement in modern vehicle system maintenance in Science and Technical Colleges Benue State.

Methodology

The study adopted a Research and Development approach in which a quasi-experimental, pretest–posttest, non-equivalent control-group design was embedded to evaluate the SEFW. This design was appropriate because intact student groups were used, making random assignment of individual students impractical. The experimental group received instruction using the SEFW, whereas the control group received conventional instruction. Quasi-experimental designs of this type are commonly used in technical and vocational education research where intact classes are involved, and recent MVMW studies in Nigeria have similarly used quasi-experimental designs

with ANCOVA to evaluate instructional interventions. The area of the study is Benue State located in North Central Nigeria where several Science and Technical Colleges offer MVMW programmes.

The study involved 74 MVMW students: 58 constituted the experimental group and 16 constituted the control group. The groups were subjected to pretest assessment before the intervention and posttest assessment after implementation. The population was made up of six Science and Technical Colleges that had the modern tools and equipment for instruction. Census sampling technique was used (all respondent) were used because the size of the population was manageable. Two instruments were used. The first was a 30-item industry-aligned Practical Skills Competencies on Modern Motor Vehicle System Maintenance (PSCMMVSM) checklist, designed to assess students' ability to perform modern vehicle maintenance tasks. The second was a 30-item multiple-choice Achievement Test measuring students' knowledge of modern vehicle system maintenance, administered as both pretest and posttest**.**

The instrument Practical Skills Competencies on Modern Motor Vehicle System Maintenance (PSCMMVSM) checklist, designed to assess students' ability to perform modern vehicle maintenance tasks. The second was a 30-item multiple-choice Achievement Test was given both face and content validation. Three experts conducted the validation of the instrument. Two from Rev.Fr Moses Orshio Adasu University, Makurdi, Benue State were consulted: one in automobile technology and one from measurement and evaluation, one from Joseph Sarwuan Tarka University, Makurdi in the Department of engineering (mechanical) was also consulted. These experts reviewed the instrument for clarity, relevance and made sure to restructure the questionnaire so that it aligned with the purpose of the research study. Their input was used to refine the instruments before they were used for the study.

The reliability of the research instrument was established through a trial test, the trial testing was conducted in Nasarawa state which location is outside the intended study area but have similar characteristics of interest similar to the main study area. Specifically; Government Science and Technical College Assakyo, Government Science and Technical college mada, Data were collected from 30 respondents and 40 questionnaire items were used and subjected to reliability analysis using Cronbach alpha which is equivalent to Kuder Richardson (KR-20) for dichotomous data. The Cronbach alpha coefficient was 0.89.

The data was collected from Rev. fr. Moses Orshio Adasu University Science and Technical Makurdi, Government Science and Technical College Otupko which formed the experimental group, Government Science and Technical College Zaki Biam, Government Science and Technical College Guma, Government Science and Technical College Tsar and St Joseph Science and Technical College Makurdi which formed the control group, using assistant from the various selected institutions (Teachers and workshops technician) who assisted in administering the instruments to the respondents. The choice of the method use for data collection was because it will reduced the researchers influence on social desirability bias, allowing respondents to answer more privately and honestly.

The experimental group was taught using the SEFW. Instruction included demonstration followed by guided student practice, observation-based activities, project tasks and problem-solving exercises. Students were exposed to modern diagnostic procedures and relevant equipment. The control group continued with conventional teaching. The intervention reflected the framework's central assumption that practical competence develops most effectively when students repeatedly connect technical knowledge with authentic maintenance tasks, consistent with current evidence supporting competency-based and project-oriented approaches in motor vehicle

mechanics education. The intervention was implemented using eight weeks. Means and standard deviations were used to answer the research questions. ANCOVA was used to test the hypotheses at the .05 level, with the respective pretest scores serving as covariates. ANCOVA was selected because it permits posttest group comparisons while statistically controlling for initial differences between group.

Result

Research Question 1: Does the developed Skills Enhancement Framework improve students' practical competence in modern vehicle system maintenance in Science and Technical Colleges in Benue State?

Table 1 presents the pretest and posttest practical competence scores.

Table 1: Descriptive Statistics of pre and post students' practical competence in modern vehicle system maintenance in Science and Technical Colleges

	Experimental and Control groups	Mean	Std. Deviation	N
Pre practical scores	Experimental group	10.0345	1.53286	58
	Control group	10.06	1.95	16
	Difference	0.03		
Post practical scores	Experimental group	32.21	1.97	58
	Control group	27.38	1.50	16
	Difference	4.83		

From Table 1 shows before the framework for improving students' practical competence in modern vehicle system maintenance was implemented 58 students in the experimental group had mean practical competence in modern vehicle system maintenance as 10.03 with standard deviation of 1.53 while the 16 students in the control group had the mean of 10.06 with standard deviation of 1.95. The noted small difference of 0.02 is an indication that prior to the framework implementation, both students in the two groups had similar practical competence in modern vehicle system maintenance. After implementation of the framework on the experimental group and conventional method on the control group, the students in the experimental group have their mean as 32.20 and standard deviation of 1.97 while the students in the control group have their mean as 27.37 and standard deviation of 1.50. The big difference of 4.8319 in favour of the experimental group can be used to answer the question that the developed skills enhancement framework has improved students' practical competence in modern vehicle system maintenance in Science and Technical Colleges.

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Research Question 2. Does the developed Skills Enhancement Framework improve students' achievement in modern vehicle system maintenance in Science and Technical Colleges Benue State?

To answer the research question, the related data were analyzed and presented in Table 2 below:

Table 2: Descriptive Statistics of pre and post students' achievement **in modern vehicle system maintenance in Science and Technical Colleges**

	Experimental and Contrrol groups	Mean	Std. Deviation	N
Pre Achievement scores	Experimental group	5.67	3.77	58
	Control group	6.38	4.73	16
	Difference	0.70		
Post Achievement scores	Experimental group	24.14	3.60	58
	Control group	19.88	3.59	16
	Difference	4.26		

Table 2 shows that before the framework for improving students' achievement in modern vehicle system maintenance was implemented 58 students in the experimental group had mean achievement in modern vehicle system maintenance as 5.67with standard deviation of 3.77 while the 16 students in the control group had the mean of 6.38 with standard deviation of 4.73. The noted small difference of 0.70 is an indication that prior to the framework implementation, both students in the two groups have similar achievement level in modern vehicle system maintenance. After implementation of the framework on the experimental group and conventional method on the control group, the students in the experimental group had their mean as 24.13 and standard deviation of 3.60 while the students in the control group had their mean as 19.88 and standard deviation of 3.59. The big difference of 4.26 in favour of the experimental can be used to answer the question that the developed skills enhancement framework has improved students' achievement in modern vehicle system maintenance in Science and Technical Colleges.

Test of $H0_1$

Table 3: Tests of Between-Subjects Effects of students' practical competence in modern vehicle system maintenance

Dependent Variable: Post practical scores

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	298.22[a]	2	149.11	42.38	.000
Intercept	1437.91	1	1437.91	408.64	.000
PrePract	5.44	1	5.44	1.55	.218
Group	293.35	1	293.35	83.37	.000
Error	249.83	71	3.52		
Total	72408.00	74			
Corrected Total	548.05	73			

a. R Squared = .544 (Adjusted R Squared = .5)

From Table 3 reading the ANCOVA table of using the row heading 'Group', we have F (2, 71) =83.37, p=0.000 < 0.05, the noted difference between experimental and control is statistically significant and the hypothesis which state that the developed skills enhancement framework does not significantly improve students' practical competence in modern vehicle system maintenance in Science and Technical Colleges is rejected.

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H0$_2$: The developed skills enhancement framework does not significantly improve students' achievement in modern vehicle system maintenance in Science and Technical Colleges.
To test the hypothesis, the analyzed results is presented in Table 18 below:

Table 4: Tests of Between-Subjects Effects of students' achievement in modern vehicle system maintenance

Dependent Variable: Post Achievement scores

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	248.99[a]	2	124.49	9.69	.00
Intercept	8694.35	1	8694.35	677.19	.000
PreAch	21.09	1	21.09	1.64	.20
Group	236.92	1	236.92	18.45	.00
Error	911.56	71	12.84		
Total	41046.00	74			
Corrected Total	1160.54	73			

a. R Squared = .22 (Adjusted R Squared = .19)

From Table 4 reading the ANCOVA table of using the row heading 'Group', we have, $F(2,71) = 18.45$, $p = 0.000 < 0.05$ the noted difference between experimental and control is statistically significant and the hypothesis which state that the developed skills enhancement framework does not significantly improve students' achievement in modern vehicle system maintenance in Science and Technical Colleges is rejected.

Findings

The finding is consistent with Onwusa et al. (2024), who reported that students taught through competency-based teaching performed better in MVMW practical skills than their counterparts in the control group. It also agrees with Aireruor et al. (2024), whose study found project-based teaching particularly useful for developing psychomotor skills in motor vehicle mechanics. The agreement between these studies and the present finding is understandable because practical trades require learners to move beyond explanation into repeated performance, feedback and correction.

The improvement can also be linked to the design of the SEFW itself. Rather than treating equipment, teaching methods, curriculum content and industry exposure as separate concerns, the framework brought them together. Students encountered modern diagnostic procedures through demonstrations, practised them under guidance and were assessed against practical expectations. This arrangement addresses a problem identified in recent Nigerian research: the availability and adequacy of facilities remain important constraints to effective automotive training.

The second finding showed that the SEFW also improved students' achievement. The experimental group recorded a posttest mean of 24.13 compared with 19.88 for the control group. The significant ANCOVA result indicates that the improvement was unlikely to be attributable solely to initial differences between the groups.

The findings also have implications beyond the classroom. The automobile industry's transition towards digitally controlled, hybrid and electric systems means that graduates need

continuous opportunities to update their competencies. The ILO (2024) emphasises reskilling and upskilling as important responses to technological and green transitions. Similarly, UNESCO-UNEVOC (2024) stresses the importance of identifying emerging competencies and incorporating them into future-oriented TVET curricula. The SEFW responds to this need by incorporating technology scanning and evaluation as continuing activities rather than treating curriculum development as a one-time exercise.

These gains should nonetheless be read with some caution. Because intact classes rather than individually randomised students were assigned to the experimental and control conditions, some of the observed advantage could reflect pre-existing class-level differences that pretest scores and the ANCOVA covariate do not fully capture. The relatively modest sample (71 students) also limits how far the findings can be generalised across Benue State's Science and Technical Colleges, and not every Nigerian study in this area reports effects as large as those found here — for instance, interventions relying on a single strategy such as demonstration alone (Okotubu, 2020) have tended to report smaller achievement gains than the combined, multi-phase approach used in SEFW. Replication across more colleges, and with random assignment where feasible, would strengthen confidence in the size of the effect.

Conclusion

This study provides evidence that a structured, four-phase Skills Enhancement Framework can improve both the practical competence and the achievement of Motor Vehicle Mechanics Work students beyond what conventional instruction achieves. The central lesson is that practical competence in a fast-changing trade like automotive maintenance is best built not by adding isolated practical sessions to an existing curriculum, but by deliberately aligning needs assessment, instructional design, implementation and evaluation around current industry demands. Closing the gap between what Science and Technical Colleges teach and what contemporary automobile workshops require depends on adopting this kind of integrated, iterative approach rather than piecemeal reform.

Recommendations

1. Science and Technical Colleges should adopt the SEFW's four-phase cycle — needs assessment, design, implementation and evaluation/feedback — rather than isolated elements of it, so that curriculum content stays aligned with current industry diagnostic requirements through the Needs Assessment phase in particular.
2. Modern diagnostic facilities, including OBD-II scanners, digital testing equipment, oscilloscopes and appropriate EV training resources, should be provided and maintained.
3. MVMW instructors should receive regular professional development in electronic diagnostics, hybrid/electric vehicle technology and emerging automotive systems.
4. Demonstration, guided practice, project work and problem-solving should be given greater emphasis in practical MVMW instruction, consistent with the Implementation phase of the SEFW.
5. Technical Colleges should strengthen partnerships with automobile industries through industrial attachment, guest instruction, workshop visits and joint skills-development activities.
6. The SEFW should be reviewed periodically, using its built-in Evaluation/Feedback phase, so that new automobile technologies and emerging industry competencies can be incorporated.

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