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BRIDGING THEORY AND PRACTICE IN AUTOMOTIVE EDUCATION: THE INSTRUCTIONAL EFFECTIVENESS OF THE INNOVATED LUBRICATION PUMP TRAINER

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ABSTRACT

The growing demand for skilled automotive technicians highlights the need for instructional approaches that effectively integrate theory with practice. This study examined the instructional effectiveness of the Innovated Lubrication Pump Trainer in strengthening student competencies in automotive servicing. Grounded in Situated Learning Theory, the intervention was designed to provide authentic and contextualized learning experiences compared to traditional lecture-based instruction. A quasi-experimental design with a nonequivalent control group was employed among senior high school students enrolled in the Automotive Servicing strand at Carrascal National High School. The experimental group was taught using the Innovated Lubrication Pump Trainer, while the control group received conventional instruction. Student performance was measured through a validated achievement test on lubrication system competencies. Results revealed that students exposed to the intervention achieved higher levels of mastery and demonstrated more consistent performance than those taught through traditional methods. Statistical analysis further confirmed a significant difference between the two groups, providing strong evidence that the intervention positively influenced student outcomes. The findings underscore the value of integrating learner-centered and authentic instructional tools into technical-vocational education. The Innovated Lubrication Pump Trainer offers a practical and scalable model for bridging the gap between classroom learning and workplace application. Implications of the study extend to curriculum development, teacher training, and policy initiatives aimed at advancing competency-based and industry-aligned instruction.

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KEYWORDS: Automotive Education, Instructional Intervention, Situated Learning, Technical-Vocational Training

INTRODUCTION

In today's rapidly evolving technological landscape, the demand for highly skilled automotive technicians continues to rise globally. Automotive technology education is crucial in equipping learners with the practical competencies required to meet industry standards and ensure employability (Jebba et al., 2024). However, traditional teaching methods emphasizing theoretical instruction often provide insufficient hands-on experience, creating a gap between classroom learning and real-world application (Muhsan & Albarody, 2019). To address this challenge, integrating authentic and contextualized learning tools, grounded in educational frameworks such as Situated Learning Theory (SLT), offers a promising pathway for enhancing technical education by situating knowledge within meaningful, real-world tasks (Bridges et al., 2016).

This study aligns with the United Nations Sustainable Development Goal 4, which emphasizes inclusive and equitable quality education and lifelong learning opportunities (United Nations, 2019). In the Philippine context, Republic Act No. 10931, or the Universal Access to Quality Tertiary Education Act, underscores the importance of improving instructional resources to enhance educational quality. At the same time, TESDA's competency-based framework highlights the need for industry-aligned training that responds to labor market demands (TESDA, 2020). Despite these initiatives, many institutions still face barriers, such as limited access to updated training equipment, inadequate funding, and a lack of instructional materials that reflect actual workplace conditions (Delgado & Ramos, 2019). These constraints have been observed among Carrascal National High School students, where limited exposure to practical training has hindered skill acquisition in automotive technology education (Local Education Office Report, 2023).

To respond to these challenges, this study evaluated the instructional effectiveness of the Innovated Lubrication Pump Trainer as a contextualized learning tool for automotive servicing. Guided by the principles of SLT, the intervention was designed to strengthen students' mastery of competencies through authentic practice and applied learning experiences. Specifically, the study compared the performance of students taught by the trainer to that of students taught using traditional instruction. The results revealed that the experimental group outperformed the control group in terms of mean achievement and demonstrated more consistent performance, with significantly reduced variability. These findings provide empirical support for integrating innovative, learner-centered tools in automotive education, affirming their potential to bridge the gap between theory and practice and promote excellence and equity in student learning outcomes.

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METHODOLOGY

Research Design

This study employed a quasi-experimental design utilizing the nonequivalent control group approach. The design was selected to evaluate the instructional effectiveness of the Innovated Lubrication Pump Trainer compared to traditional teaching methods in automotive technology education. Two groups of students were exposed to different instructional strategies: the control group received conventional lecture-based instruction, while the experimental group engaged with the Innovated Lubrication Pump Trainer as a contextualized, hands-on learning tool. Pretest and posttest measures were administered to assess students' mastery of targeted competencies, and the results were analyzed to determine the impact of the intervention.

Participants

The study was conducted among Grade 12 students enrolled in the Automotive Servicing strand at Carrascal National High School during the academic year 2023–2024. A total of 83 students participated, with 41 assigned to the experimental group and 42 to the control group. The grouping followed intact class assignment, as randomization was not feasible within the institutional setting. All participants had similar academic backgrounds and had previously completed the basic competencies required for automotive servicing. Ethical clearance was secured from the local education office, and informed consent was obtained from the students and their parents or guardians.

Instrument and Intervention

The instructional intervention consisted of the **Innovated Lubrication Pump Trainer,** a teaching device designed to simulate real-world automotive lubrication systems. The trainer was developed based on the principles of Situated Learning Theory, allowing students to apply theoretical knowledge within authentic practice environments. For the control group, traditional instruction methods were employed, consisting of teacher-led lectures, textbook discussions, and visual aids. Learning outcomes were measured through a teacher-validated achievement test focusing on competencies in lubrication systems, including identification, function, maintenance, and troubleshooting. The test underwent content validation by three subject-matter experts and achieved a reliability coefficient (Cronbach's α) of 0.87, indicating high internal consistency.

Data Collection Procedure

Data collection was carried out in three phases. Both groups completed a pretest in the first phase to establish baseline knowledge and ensure comparability. In the second phase, the intervention was implemented over four weeks, with the experimental group utilizing the Innovated Lubrication Pump Trainer during laboratory sessions, while the control group received standard instruction. The same

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instructor taught both groups to minimize teacher-related variability. In the final phase, a posttest identical in structure to the pretest was administered. The results were collected, coded, and prepared for statistical analysis.

Data Analysis

Descriptive statistics, including mean and standard deviation, were used to summarize student performance and identify patterns in achievement across groups. An independent samples *t*-test was conducted to determine whether a statistically significant difference existed between the control and experimental groups' posttest scores. Before analysis, Levene's Test for Equality of Variances was performed to check assumptions. Given the unequal variances observed, results from the "equal variances not assumed" test were reported. The significance level was set at $p < .05$. Statistical analyses were conducted using SPSS version 26.

RESULTS AND DISCUSSION

Table 1
Group Statistics on the Posttest Scores of the Control and Experimental Groups

Group Statistics				
Group	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Control Group	42	21.5952	1.98850	.30683
Experimental Group	41	26.8780	1.07692	.16819

The findings of this study provide compelling evidence of the effectiveness of the instructional intervention in enhancing student learning outcomes. The descriptive statistics revealed that the experimental group (n = 41, M = 26.887, SD = 1.07) outperformed the control group (n = 42, M = 21.59, SD = 1.98), underscoring the positive impact of the intervention on students' mastery of the targeted competencies. This substantial difference suggests that the intervention offered a more effective learning experience than traditional instruction. Consistent with prior studies, these results highlight the value of Technology-enhanced learning environments, specifically showing measurable benefits, with one study reporting a 75% increase in student motivation and 10% improvement in academic performance compared to traditional settings (Duterte, 2024).

Beyond the higher mean scores, the reduced variability in the experimental group (SD = 1.07) compared to the control group (SD = 1.98) further strengthens the claim of instructional effectiveness. The narrower spread of scores indicates that students exposed to the intervention achieved higher average performance

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and demonstrated more consistent outcomes. Such consistency is a crucial marker of instructional equity, suggesting that the intervention helped minimize performance disparities and reach learners across different ability levels. This aligns with the earlier findings of Singer et al. (2020), who showed that authentic collaborative learning experiences focused on diversity and inclusion helped students develop stronger STEM identities and a sense of belonging, benefiting underrepresented students through improved communication and collaboration skills.

These findings emphasize that the intervention yielded dual benefits: enhancing overall achievement and ensuring greater uniformity of learning outcomes. This dual effect is particularly valuable in educational practice, as it supports excellence and inclusivity in learning. The results affirm the pedagogical value of integrating learner-centered, authentic instructional approaches, particularly in skill-based and technical disciplines where mastery and consistency are essential for future professional competence. Furthermore, by demonstrating improved outcomes and reduced variability, this study provides empirical support for adopting innovative interventions as a sustainable means of addressing the diverse needs of students in higher and technical education.

Table 2.
Independent Samples t-Test Results Comparing the Posttest Scores of the Control and Experimental Groups

	Levene's Test for Equality of Variances		*t-test for Equality of Means*					
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	95% CI of the Difference (Lower)	(Upper)
Equal variances assumed	31.046	.000	-14.998	81	.000	-5.28281	-5.98366	-4.58196
Equal variances not assumed			-15.098	63.466	.000	-5.28281	-5.98194	-4.58368

The independent samples t-test results provide strong statistical evidence supporting the effectiveness of the instructional intervention. Levene's Test indicated unequal variances ($F = 31.046$, $p < .001$), leading to the use of the "equal variances not assumed" procedure. Findings revealed a statistically significant difference between groups, $t(63.47) = -15.10$, $p < .005$. The experimental group ($M = 26.88$) outperformed

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the control group (M = 21.60), with a mean difference 5.28. The 95% confidence interval confirmed the robustness of the difference, which further validated the meaningful impact of the intervention on student achievement. This finding aligns with evidence that technology integration in teaching enhances performance by fostering greater engagement, enabling personalized learning experiences, and promoting the development of essential digital literacy skills (Ahmad & Hamad, 2020; Suyitno et al., 2024). Rejecting the null hypothesis indicates that the intervention genuinely improved learning outcomes compared to traditional instruction.

These findings carry significant pedagogical implications. The statistically higher performance of the experimental group highlights the value of adopting innovative and student-centered instructional strategies. Such approaches are consistent with prior studies, which indicate that professional development programs focused on instructional technology yield measurable benefits when implemented with high fidelity. These benefits include improved lesson quality and positive student outcomes (Martin et al., 2010). The consistency of performance gains suggests that the intervention was effective across diverse learners, underscoring its potential as a scalable and adaptable model for educational practice.

From a broader perspective, these results also signal important directions for institutional support and policy. Administrators and policymakers may consider investing in professional development programs and allocating resources to promote integrating innovative teaching practices. As emphasized by Askell-Williams & Koh (2020), many educational programs have short lifespans despite substantial resource investments, emphasizing the need for systems perspectives that consider interactions between goals, processes, and outcomes for sustained implementation. The educational system can foster excellence and equity in learning outcomes by bridging classroom-level interventions with institutional initiatives.

CONCLUSION

The study demonstrated that the instructional intervention significantly enhanced student learning outcomes compared to traditional instruction. The experimental group achieved higher mean scores and displayed more consistent performance, as confirmed by both descriptive statistics and the independent samples t-test. These results prove that the intervention effectively improved mastery of targeted competencies.

The findings highlight the importance of adopting learner-centered and innovative instructional strategies in higher and technical education. By fostering improved achievement and greater equity among students, the intervention is a promising approach for classroom practice, curriculum enhancement, and broader educational policy.

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