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# IMPACT OF EQUIPMENT AVAILABILITY ON THE TECHNICAL SKILL DEVELOPMENT OF AUTOMOTIVE STUDENTS AT BENGUET STATE UNIVERSITY – BOKOD CAMPUS

John Rey J. Corbe

*Technical Vocational-Livelihood Education Department, Benguet State University – Bokod Campus, Bokod, Benguet, Philippines*

## ABSTRACT

The study aimed to determine the effect of equipment availability to the technical skill development of automotive students of Benguet State University – Bokod Campus for School Year 2024-2025. A quantitative descriptive-correlational research design was used. The respondents of the study were fifty (50) automotive students enrolled in the Bachelor of Technical-Vocational Teacher Education (BTVTED) and Bachelor of Industrial Technology (BIT) programs. A researcher-made questionnaire comprising three parts, an equipment availability checklist, a four-point condition and skill proficiency rating scale, and a skills execution and challenges checklist, was validated by automotive education experts and pilot-tested prior to administration. Data were analyzed using frequency counts, percentages, weighted means, and Spearman rank correlation. Results showed that basic hand tools, power tools, and safety equipment were widely available and maintained in good to excellent condition, while advanced automotive machines such as engine analyzers and hydraulic lifts were largely unavailable or rated only fair. Students' self-rated proficiency was correspondingly higher in basic mechanical tasks and markedly lower in technology-dependent diagnostic skills. Spearman rank correlation yielded $r_s = 0.92$ ($t = 5.86$, $df = 6$, $p < .01$), indicating a strong, statistically significant positive association between equipment availability and self-rated technical skill development. The most frequent problems during the training were lack of access to equipment, unavailable machines, time restrictions, and the overcrowding of the workshops. The report recommends that the procurement of modern diagnostic equipment be prioritized, preventative maintenance programs be implemented, improvements to the workshop scheduling be made, and industry relationships be developed to improve the quality of practical training and employability of the graduates.

**Keywords:** *equipment availability, technical skill development, automotive education, TVET, Spearman rank correlation, workshop equipment condition*

## INTRODUCTION

The quality of Technical and Vocational Education and Training (TVET) is closely related to the adequacy and functionality of the workshop equipment, tools, and training facilities. Studies of TVET programs globally have consistently indicated poor supply of equipment and lack of maintenance as systemic barriers to competency-based training, resulting in graduates not being prepared for the evolving demands of modern industry (UNESCO, 2016). This challenge is particularly acute in developing countries where resource constraints limit institutions' ability to purchase, replace, or maintain specialized equipment in line with current industry standards.

The current study is based on Kolb's (1984) experiential learning theory, which argues that knowledge and skill are best learned by direct, hands-on experiences with actual tools and environments. Kolb's model shows a four-stage cycle of (1) concrete experience, (2) reflective observation, (3) abstract conceptualization, and (4) active experimentation. The idea is that technical mastery in automotive education is developed through iterative cycles of tool application, error detection, and technique refinement. With the lack of equipment or defective equipment, training is limited to passive observation or theory which does not have the same effect on improving the skill as practice, thereby breaking the cycle at the basic stages of tangible experience and active experimentation (Amadi & Eniekenemi, 2021).

A study conducted by Anwar et al. (2023) found that a majority of the technical-vocational institutions in the Philippines lack training materials. And so, it's common for teachers and students to have to spend money on the tools they need to teach well. Automotive programs are especially resource-intensive, requiring a comprehensive array of hand tools, power tools, diagnostic machines, and personal protective equipment, such as all requiring both significant upfront investment and ongoing maintenance. The gap between what is available in the institution and what the industry demands becomes expansive when advanced diagnostic equipment like engine analyzers, OBD-II scanners, and hydraulic lifts are not available or maintained well, thus directly restricting students' access to technology-based skills that are needed to work in the present-day automotive industry (Arante, 2022).

The condition and adequacy of laboratory resources have been found to directly affect the quality of training and student achievement (Carpio, 2025; Ramos, 2021). The gap between the laboratory equipment available within the institutions and the industry standards has been linked to low competency levels among vocational graduates (Mutuku Ngulu et al., 2022; Alabar et al., 2025). However, despite the body of evidence, relatively few studies have statistically quantified this relationship in an ordinal correlation approach in the context of Philippine automotive TVET. Therefore, this study was conducted at Benguet State University–Bokod Campus to systematically assess the availability and condition of automotive tools and equipment and evaluate the students' self-rated technical skill levels across major automotive competency areas; and statistically examine the strength of the association between equipment availability and self-rated skill development using the Spearman rank correlation coefficient. The findings are expected to provide evidence-based guidance for institutional planning, resource allocation, and curriculum delivery in automotive technology programs. More specifically, the study aims to align training outcomes with the employability requirements of the technical and industrial labor market.

**Research Questions**

This study aimed to determine the level and association between equipment availability and students' self-rated technical skill development at Benguet State University – Bokod Campus. Specifically, it sought to answer the following questions:

1. What tools and equipment are available in the automotive engineering laboratory at Benguet State University–Bokod Campus in terms of
    1.1. Hand tools
    1.2. Power tools
    1.3. Automotive machines
    1.4. Safety equipment and personal protective equipment (PPE)?
2. What is the condition of the available automotive tools and equipment in terms of:
    2.1. Hand tools
    2.2. Power tools
    2.3. Automotive machines
    2.4. Safety equipment and PPE?
3. What is the self-rated technical skill level of automotive students in using:
    3.1. Hand tools
    3.2. Power tools
    3.3. Automotive machines
    3.4. Safety equipment and PPE?
4. Is there a significant association between equipment availability and students' self-rated technical skill levels in the following terms:
    4.1. Hand tools
    4.2. Power tools
    4.3. Automotive machines?
5. In which technical competency areas do automotive students exhibit the lowest self-rated proficiency, and how does this finding correspond to equipment availability?
6. What challenges do automotive students encounter in their technical training?

## METHODOLOGY

### Research Design

The present study adopted a quantitative descriptive-correlational research design. The descriptive component documented the availability and condition of automotive tools and equipment and determined the self-rated technical skill levels of students using frequency counts, percentages, and weighted means. The correlational part statistically analyzed the relationship between availability of equipment and self-rated skill development through the Spearman rank correlation coefficient (rs). This type of correlation is appropriate for ordinal data, small sample sizes, and distributions that do not assume normality (Creswell & Creswell, 2018). No experimental manipulation of variables was carried out.

### Theoretical Framework

The study is based on Kolb's (1984) Experiential Learning Theory, which suggests that skill acquisition is a four-stage, cyclical process of concrete experience, reflective observation, abstract conceptualization, and active experimentation. With regard to automotive TVET, this theory postulates that students achieve technical proficiency through their continual participation in using working tools and equipment. Equipment availability, therefore, is not simply a logistical concern but a pedagogical necessity: without access to the stage of concrete experience, the other stages of the cycle cannot be completed and skill mastery cannot be attained. This framework produces a testable hypothesis that equipment availability will be positively correlated with skill development, which is formally tested in this study by the Spearman rank correlation.

### Hypotheses

**$H_0$:** No significant association between the availability of equipment and the students' self-rated technical skill level (rs = 0).
**$H_1$.** A strong positive association was found between equipment availability and students' self-rated technical skill level (rs > 0).

### Locale of the Study

The study was conducted at the Automotive Laboratory of Benguet State University – Bokod Campus, Bokod, Benguet, Philippines, during the Academic Year 2024-2025.

### Population and Sample

The respondents were fifty (50) automotive students enrolled in the Bachelor of Technical-Vocational Teacher Education (BTVTED) and Bachelor of Industrial Technology (BIT) programs for the academic year 2024-2025. The purposive sampling criteria were for those who were directly involved in automotive training and workshop activities. The sample is a total enumeration of the available population, as all the students who qualified at the campus were included.

### Research Instrument

A researcher-made questionnaire was developed and divided into three parts: (1) an **Equipment Availability Checklist** using dichotomous Yes/No responses to assess which tools and equipment were accessible to students in the automotive laboratory; (2) a **Condition and Skill Proficiency Rating Scale** employing a four-point ordinal scale for equipment condition (1 = Poor, 2 = Fair, 3 = Good, 4 = Excellent) and self-rated skill level (1 = Novice, 2 = Proficient, 3 = Advanced, 4 = Expert); and (3) a **Skills Execution and Challenges Checklist** using Skilled/Not Skilled and Yes/No responses. The instrument was submitted to three automotive education experts for content validity review. Feedback was incorporated prior to pilot testing, which was conducted with ten students not included in the main study to assess item clarity and response consistency. The pilot test confirmed adequate clarity with no item removed.

### Data Gathering Procedure

Prior to data collection, written permission for undertaking the study was obtained from the university administration. The questionnaire was administered by the researcher personally during the scheduled class periods. Respondents were informed of the purpose of the study, the voluntary nature, and the confidentiality of their responses and were informed of their right to withdraw at any time without penalty prior to the questionnaire distribution. There were no incentives to participate.

### Treatment of Data

The following statistical tools were used for the data analysis:

The frequency counts and percentages were calculated for all the dichotomous items (Yes/No and Skilled/Not Skilled) to determine the number and proportion of respondents who reported the availability of each tool and their competence in each skill area.

Weighted means were derived from the four-point ordinal rating scales to characterize the overall status of available equipment and the mean self-rated skill proficiency level among respondents. The following interpretive ranges were adopted: 3.50-4.00 = Excellent; 2.50-3.49 = Good; 1.50-2.49 = Fair; 1.00-1.49 = Poor.

The association between equipment availability and students' self-rated skill development (Research Question 4) was statistically analyzed using the Spearman rank correlation coefficient (rs). Availability of equipment was coded ordinally: Fully Available = 3 Moderately Available = 2 Limited = 1. The dependent variable was the percentage of students who self-rated themselves as skilled per skill area. Both variables were ranked for the eight paired skill areas, and rs was calculated using the formula: $rs = 1 - [6\Sigma d^2 / n (n^2 - 1)]$, where d = difference between availability rank and skilled-percentage rank for each skill area, and n = 8. Statistical significance was tested at the levels of $\alpha = .05$ and $\alpha = .01$ using a two-tailed t-test with $df = n - 2 = 6$.

## Scope and Limitations

The study was limited to 50 students studying automotive at one school during the 2024-2025 academic year. The present study does not rely on objective measurements. People who are not very good at a skill may think they are better at it than they actually are. This is known as "self-report bias." This can include the Dunning-Kruger effect, social desirability bias, etc. People who are not good at a skill may say that they are better than they are. These effects may lead to skill ratings that are too high, particularly in areas where students have little hands-on practice. Therefore, the results should be viewed as indicators of perceived competence, not actual competence. The Spearman correlation is calculated over 8 pairs of skill areas, not 50 individual student records, and therefore only captures area-level patterns and cannot be directly related to individual-level relationships. No causal inference is made.

## RESULTS

This section presents the quantitative findings organized according to each research question. Results are reported using frequency tables, weighted means, and Spearman rank correlation. Descriptive interpretation of patterns follows each table.

### Availability of Automotive Tools and Equipment

Table 1 presents the frequency and percentage distribution of availability of automotive tools and equipment as reported by the 50 respondents. A response of “Yes” indicates the equipment was available or accessible during lab activities, and a response of “No” indicates the equipment was not available or accessible.

**Table 1. Table 1. Availability of Automotive Tools and Equipment Used in Automotive Servicing NC I and NC II Training (n = 50)**

| Category | Tool / Equipment | Available (n) | Not Available (n) | Rate (%) | Availability Level |
|---|---|---|---|---|---|
| Hand Tools | Wrenches | 50 | 0 | 100% | Fully Available |
| | Screwdrivers | 50 | 0 | 100% | Fully Available |
| | Pliers | 50 | 0 | 100% | Fully Available |

| | | | | | |
|---|---|---|---|---|---|
| | Ratchet & Socket Set | 50 | 0 | 100% | Fully Available |
| | Hammers | 50 | 0 | 100% | Fully Available |
| | Files | 28 | 22 | 56% | Partially Available |
| | Measuring Tools | 38 | 12 | 76% | Largely Available |
| Power Tools | Impact Wrench | 50 | 0 | 100% | Fully Available |
| | Air Ratchet | 40 | 10 | 80% | Largely Available |
| | Cordless Drill | 17 | 33 | 34% | Limited |
| | Grinder | 50 | 0 | 100% | Fully Available |
| | Air Compressor | 50 | 0 | 100% | Fully Available |
| | Heat Gun | 9 | 41 | 18% | Limited |
| Automotive Machines | Engine Analyzer | 3 | 47 | 6% | Limited |
| | Hydraulic Lift | 8 | 42 | 16% | Limited |
| | OBD-II Scanner | 39 | 11 | 78% | Largely Available |
| | Transmission Jack | 38 | 12 | 76% | Largely Available |
| | Cooling System Tester | 14 | 36 | 28% | Limited |
| Safety / PPE | Safety Gloves | 50 | 0 | 100% | Fully Available |
| | Safety Goggles | 50 | 0 | 100% | Fully Available |
| | Steel-toed Boots | 38 | 12 | 76% | Largely Available |

| | | | | | |
|---|---|---|---|---|---|
| | Face Shield | 50 | 0 | 100% | Fully Available |
| | Fire-resistant Clothing | 39 | 11 | 78% | Largely Available |

*Note. Values represent the frequency and percentage of respondents who confirmed that each tool or equipment item was available in the automotive laboratory. Availability levels were interpreted as follows: Fully Available = 100%; Largely Available = 76–99%; Partially Available = 51–75%; Limited = 50% or below.*

The results showed that the respondents generally reported the availability of basic automotive tools and equipment. All five core hand tools, including wrenches, screwdrivers, pliers, ratchet sets, and hammers, were 100% available, as were welding equipment, measuring instruments, universal access tools, and personal protective equipment. The results indicated that the students had continuous access to the basic equipment required for typical automotive servicing jobs and simple laboratory activities.

In contrast, a number of highly specialized automotive machines were reported to have substantially lower availability levels. The lowest availability was for engine analyzers (6%). Next lowest were hydraulic lifts (16%), cooling system testers (28%), heat guns (18%) and oscilloscopes (34%). These are equipment widely used in advanced automotive diagnostics and repair procedures. This unavailability indicates that students may have had less access to hands-on training on specific diagnostic technologies.

The pattern observed is consistent with Kolb's (1984) experiential learning theory that stresses the importance of concrete experience and active experimentation in the development of technical competence. Access to laboratory equipment is sufficient to allow for repeated practice, while limited access to specialized equipment can limit students' opportunities to develop competencies that rely on advanced diagnostic procedures. The findings provide descriptive evidence of a substantial variation in availability of laboratory equipment across automotive skill areas and may have implications for students' opportunities to develop both fundamental and advanced technical competencies.

## Condition of Automotive Tools and Equipment

Weighted Mean Ratings of the Condition of Automotive Tools and Equipment Used in Automotive Servicing NC I and NC II Training

**Table 2. Condition of Automotive Tools and Equipment (n = 50)**

| Category | Weighted Mean | Interpretation | Condition | Training Implication |
|---|---|---|---|---|
| Hand Tools | 3.18 | Good | Serviceable; minor wear | Supports routine task training |

| | | | | |
|---|---|---|---|---|
| Power Tools | 3.05 | Good | Functional; slight wear | Adequate for practical exercises |
| Automotive Machines | 2.31 | Fair | Partially functional | Constrains advanced-skill training |
| Safety / PPE | 3.42 | Good–Excellent | Well-maintained | No safety risks noted |

*Note. Ratings were based on a four-point scale: 1 = Poor, 2 = Fair, 3 = Good, and 4 = Excellent. Interpretation of weighted means: 1.00–1.49 = Poor; 1.50–2.49 = Fair; 2.50–3.49 = Good; and 3.50–4.00 = Excellent.*

In Table 2, it is shown that hand tools (WM = 3.18), power tools (WM = 3.05) and safety equipment/personal protective equipment (PPE) (WM = 3.42) were generally rated as good. The resources are thus functional and adequate for routine laboratory work. The PPE and safety equipment category had the highest weighted mean of the four categories. This implies that, in general, the respondents felt that the resources were available and well-maintained during lab sessions. These results demonstrate the institution's commitment to providing a safe environment for practical automotive training.

On the other hand, automobile machinery got the lowest weighted mean (WM = 2.31) which means a fair condition grade. This indicates that some devices are still functioning and some may need to be repaired, maintained or replaced before they can be used regularly during laboratory training.

Automotive machines are usually the biggest limitation in terms of condition and usage compared with the other types of equipment.

The relative low grade for automobiles has major implications for competency-based automotive education. With the use of specialized equipment like hydraulic lifts, engine analyzers and other diagnostic tools students are able to practice complex technical processes that are becoming more and more required in the automobile sector. Moreover, the scarce availability or inconsistent performance of these machines, may also contribute to the reduced opportunities for students to participate in the hands-on activities repeatedly required to learn more complex technical skills. The findings are consistent with the previous studies which highlighted the significance of functional laboratory equipment in technical and vocational education. There is a chronic problem of poor maintenance of equipment in TVET programmes which affects the quality of training (UNESCO, 2016). Similarly, Mutuku Ngulu et al. (2022) found that poorly maintained workshop equipment restricts students' ability to participate in practical activities and acquire industry-relevant skills. Therefore, the results of the present study indicate that improving the condition and maintenance of specialized automotive machines can enhance the effectiveness of laboratory training and help students develop technical skills.

## Self-Rated Technical Skill Levels of Automotive Students

Table 3 shows the frequency distribution of the self-rated technical ability levels of the students in the 14 automobile servicing competencies. The competency levels were grouped into four categories: Novice (can execute the activity only with direction), Proficient (can complete the task with minimum supervision), Advanced (can perform independently), and Expert (can perform autonomously and demonstrate the proficiency to others).

**Table 3. Self-Rated Skill Level by Automotive Skill Area (n = 50)**

| Skill Area | Novice (n) | Proficient (n) | Advanced (n) | Expert (n) | Dominant Pattern & Interpretation |
|---|---|---|---|---|---|
| Brake System Servicing | 2 | 8 | 27 | 13 | Advanced–Proficient (High competence) |
| Cooling System Maintenance | 1 | 9 | 27 | 13 | Advanced–Proficient (High competence) |
| Wheel Alignment and Balancing | 2 | 11 | 25 | 12 | Proficient–Advanced (Adequate–High) |
| Engine Diagnostics and Repair | 3 | 14 | 24 | 9 | Proficient (Moderate competence) |
| Exhaust System Repair | 4 | 16 | 22 | 8 | Proficient (Moderate competence) |
| Tire Changing and Balancing | 6 | 19 | 17 | 8 | Proficient–Novice (Developing) |
| Welding and Fabrication | 7 | 18 | 17 | 8 | Proficient–Novice (Developing) |
| Hydraulic Systems Operation | 8 | 19 | 16 | 7 | Proficient–Novice (Emerging) |
| Fuel System Maintenance | 7 | 20 | 16 | 7 | Proficient–Novice (Emerging) |
| Transmission Repair | 11 | 21 | 13 | 5 | Novice–Proficient (Low–Moderate) |
| Powertrain Systems Repair | 12 | 22 | 11 | 5 | Novice–Proficient (Low–Moderate) |

| | | | | | |
|---|---|---|---|---|---|
| Electrical Systems Diagnostics | 17 | 22 | 8 | 3 | Predominantly Novice (Low) |
| Air Conditioning Repair | 16 | 24 | 7 | 3 | Predominantly Novice (Low) |
| OBD-II Scanner Usage | 22 | 22 | 5 | 1 | Strongly Novice (Very Low) |

*Note. Values represent students' self-rated competency levels and do not reflect objectively measured technical performance. Each row totals 50 respondents. The dominant pattern was determined based on the modal competency level.*

The results show in Table 3 that students' self-rated technical proficiency varied significantly across fourteen categories of automobile servicing skills. The self-reported competence levels were highest in brake system servicing, cooling system maintenance, and wheel alignment and balancing, with the majority of respondents rating themselves as advanced or expert. The results indicate that students have better confidence in performing basic mechanical techniques that are commonly conducted during laboratory activities.

A second set of competencies, engine diagnostics and repair and exhaust system repair, was mostly scored at the proficient level, but many respondents also indicated advanced competency. In comparison, tire changing and balancing, welding and fabrication, hydraulic systems operation, and fuel system maintenance were proficient and became novice, showing a modest level of self-assessed skill and a broad range of responses.

The lowest self-rated competencies were transmission repair, powertrain systems repair, electrical systems diagnostics, air conditioning repair, and most of all, OBD-II scanner usage. The biggest proportion of respondents describing themselves as Novice (22 respondents, 44%) was found in the usage of the OBD-II scanner, and only one respondent (2%) identified as Expert. Likewise, Electrical Systems Diagnostics and Air Conditioning Repair had quite high percentages of respondents in the novice group, and relatively few respondents rated themselves as advanced or expert. These results imply that students viewed themselves as less competent in technical subjects that included specialist diagnostic procedures and electronically controlled automobile systems.

The pattern of self-rated competency is very similar to the equipment availability findings in the tables above. In general, skill areas with higher self-ratings tended to correspond to skills supported by equipment that respondents regarded as more readily available, whereas those with lower self-ratings tended to require specialist diagnostic equipment that respondents rated as less available. This observed pattern is consistent with Kolb's (1984) Experiential Learning Theory, which highlights the relevance of multiple hands-on experiences in gaining technical competence. However, the current results are based on self-assessments and so reflect students' perceived competency rather than objective measures of technical achievement.

## Association between Equipment Availability and Self-Rated Skill Development

To answer Research Question 4, Spearman rank-order correlation analysis was conducted to examine the association between the availability of laboratory equipment and students' self-rated technical skill development. Equipment availability was grouped as an ordinal variable (3 = fully available, 2 = moderately available, and 1 = limited) and was merged with the percentage of students who evaluated themselves as skilled for each of the eight associated technical competencies. Each variable was rated separately, and the squared differences of the ranks were computed for the Spearman rank-order correlation coefficient. Table 4 shows the ranked data used in the analysis.

**Table 4. Ranked Data Used in the Spearman Rank-Order Correlation Analysis (n = 8 Skill Areas)**

| Skill Area | Availability Level | Avail. Score (X) | Skilled (n) | Skilled (%) | Not Skilled (%) | Rank X | Rank Y | d² |
|---|---|---|---|---|---|---|---|---|
| Brake System Servicing | Fully Available | 3 | 39 | 78% | 22% | 7.0 | 7.5 | 0.25 |
| Cooling System Maintenance | Fully Available | 3 | 39 | 78% | 22% | 7.0 | 7.5 | 0.25 |
| Wheel Alignment / Balancing | Fully Available | 3 | 37 | 74% | 26% | 7.0 | 6.0 | 1.00 |
| Engine Diagnostics | Moderately Available | 2 | 33 | 66% | 34% | 5.0 | 5.0 | 0.00 |
| Transmission Repair | Limited | 1 | 24 | 48% | 52% | 2.5 | 4.0 | 2.25 |
| Electrical Systems Diagnostics | Limited | 1 | 23 | 46% | 54% | 2.5 | 3.0 | 0.25 |
| Air Conditioning Repair | Limited | 1 | 20 | 40% | 60% | 2.5 | 2.0 | 0.25 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| OBD-II Scanner Usage | Limited | 1 | 17 | 34% | 66% | 2.5 | 1.0 | 2.25 |
| | | | | | | | **Σd² =** | 6.50 |

*Note. Availability Score: 3 = Fully Available, 2 = Moderately Available, 1 = Limited. Tied ranks were averaged. Σd² = 6.50.*

**Table 5. Results of the Spearman Rank-Order Correlation Analysis Between Laboratory Equipment Availability and Students' Self-Rated Technical Skill Development**

Table 5 shows the results of the Spearman rank-order correlation analysis to examine the relationship between availability of laboratory equipment and students' self-rated technical skill development in the eight paired skill areas. The table summarizes the calculated Spearman correlation coefficient, test statistic, critical values, decision, and statistical interpretation of the relationship.

| Statistic | Value | Remark | Interpretation |
|---|---|---|---|
| Spearman rho (rs) | 0.9226 | — | Strong positive monotonic association |
| Σd² | 6.50 | — | Sum of squared rank differences |
| n (paired skill areas) | 8 | — | Number of paired observations |
| t-statistic | 5.8591 | df = 6 | Derived: t = rs√(n−2) / √(1−rs²) |
| Critical t (α = .05, 2-tail) | 2.447 | df = 6 | Standard t-table value |
| Critical t (α = .01, 2-tail) | 3.707 | df = 6 | Standard t-table value |
| Decision | Reject $H_0$ | p < .01 | t = 5.86 > 3.707; significant at 1% level |
| Conclusion | Significant positive association | rs = 0.92, p < .01 | Equipment availability strongly predicts self-rated skill level |

*Note. Critical t-values were obtained from the standard two-tailed t-distribution table (df = 6). The Spearman rank-order correlation coefficient was computed using $r_s = 1 - [6\Sigma d^2 / n(n^2 - 1)]$, and statistical significance was tested using $t = r_s\sqrt{(n-2)} / \sqrt{(1 - r_s^2)}$.*

The laboratory equipment availability was strongly, positively, and statistically significantly correlated with students' self-rated technical skill development (rs = 0.9226, t = 5.86, df = 6, p < .01). The calculated t-value was found to be more than the critical value at a 5% significance level (t = 2.447) and a 1% significance level (t = 3.707), which led to the rejection of the null hypothesis. Findings indicate that students perceived technical competence in the eight paired skill areas increases as equipment availability increases.

The positive correlation suggests that technical competencies tended to increase in areas of skill where laboratory equipment was more available. By contrast, competencies that required equipment that was limited in availability or in poorer condition generally had lower levels of self-rated proficiency. This pattern is apparent across the paired skill areas studied and supports the descriptive results in the preceding tables.

Findings support Kolb's (1984) Experiential Learning Theory, which suggests that learners must participate in repeated, hands-on experiences to gain skills. Students, who have sufficient access to the laboratory equipment, can perform practical exercises, get feedback, reflect on their experience, and improve their competencies through constant practice. On the other hand, the access to specialist instruments can be restricted, which in turn can restrict the opportunity for hands-on learning, especially in terms of technologically complex automotive operations.

The findings also confirm previous empirical studies on the importance of laboratory resources in technical and vocational education. The absence of equipment and the inadequacy of workshops are obstacles to competency-based learning (UNESCO, 2016). Likewise, Abdurrahman et al. (2022), Amadi & Eniekenemi (2021), Fah (2024), Carpio (2025), and Alabar et al. (2025) established a link between suitable training facilities and the development of students' technical proficiency. The observed findings thus fit with existing worldwide and local research emphasizing the need for proper laboratory resources for skill learning.

Although the strength of the observed relationship is notable, the results should be interpreted with caution. The correlation analysis used eight paired skill-area observations rather than individual student-level data (n = 8), indicating that the results represent the relationship between aggregated equipment availability and aggregated self-rated competencies across skill areas. Thus, the results should not be viewed as representing the individual student-level relationship. Moreover, as students' competencies were assessed by means of self-assessment, the reported association is that of perceived rather than objectively measured technical competence. Lastly, while the correlation is statistically significant, it does not prove causation. Other factors such as instructional strategies, laboratory time allocation, student motivation, prior experience, and frequency of practical activities may also influence technical skill development.

## Least Developed Technical Competencies

Table 6 identifies the six technical competency areas in which the smallest proportions of students self-rated as skilled, along with the likely contributing equipment access factors for each.

**Table 6. Least Developed Technical Competencies of Automotive Students (n = 50)**

| Technical Competency | Skilled (n) | Skilled (%) | Not Skilled (n) | Not Skilled (%) | Associated Equipment Factor |
|---|---|---|---|---|---|
| OBD-II Scanner Usage | 17 | 34% | 33 | 66% | Near-absent equipment; very limited practice opportunity |
| Air Conditioning Repair | 20 | 40% | 30 | 60% | Limited A/C service tools; rarely practiced |
| Electrical Systems Diagnostics | 23 | 46% | 27 | 54% | Scarce diagnostic tools; high procedural complexity |
| Transmission Repair & Maintenance | 24 | 48% | 26 | 52% | Complex; limited jacks and specialized machines |
| Powertrain Systems Repair | 24 | 48% | 26 | 52% | Complex; limited specialized machinery |
| Hydraulic Systems Operation | 27 | 54% | 23 | 46% | Hydraulic lift confirmed by only 8 respondents (16%) |

*Note. Competencies are listed in ascending order of skill. Not Skilled (%) = 100% − Skilled (%).*

Results indicate that the use of the OBD-II scanner by the respondents is the least developed technical competency, with only 17 students (34%) considering themselves technically skilled and 33 students (66%) reporting that they are not technically skilled. This is in line with the restricted availability of OBD-II diagnostic equipment in the laboratory. Respondents reported the availability of scanners, but opportunities for students to build confidence and competence through hands-on experience may have been inadequate. Because OBD-II scanners are essential equipment in modern automotive diagnostics, lack of experience may limit students' knowledge of electronic diagnostic procedures.

Some of the least developed competencies were air conditioning repair (40% skilled) and electrical systems diagnostics (46% skilled). Both require specialized diagnostic equipment and hands-on repeated practice. The relatively low proficiency reported by students may be attributed to the limited opportunities to practice these technology-dependent skills, especially when proper equipment is unavailable, is shared among several students or does not function reliably during laboratory sessions.

Transmission repair and maintenance and powertrain system repair were the skills in which 48% of respondents reported being skilled. This means that more than half of the respondents rated themselves as not yet proficient in these competencies. These skills involve complex mechanical systems that require special equipment, extended laboratory time, and repeated supervised practice. Limited access to such resources may limit opportunities for students to develop confidence and procedural competence.

For the six competencies, the highest self-rated level of competence was in operating hydraulic systems (54% skilled), but nearly half of respondents (46%) reported that they were not skilled. The not very high degree of competence can be explained by the limited availability of hydraulic lifts and related equipment, which limits students' ability to conduct multiple practical exercises using hydraulic systems.

All six competencies described in Table 6 share a common feature: they all depend on specialized automotive equipment that is either not readily available or reported to be in less than satisfactory condition. This trend is consistent with the results in previous tables showing that automotive machines had the lowest ratings for condition and availability. The results suggest that students are more inclined to report lower levels of competence in skill areas that demand access to equipment that is not readily available. These findings suggest improved laboratory resources and more chances for hands-on experience, particularly for the advanced automotive diagnostic and repair procedures that are increasingly in demand in today's auto industry.

## Challenges Encountered by Automotive Students

Table 7 shows the frequency and percentage distribution of the training challenges encountered by the 50 respondents in the Automotive Servicing NC I and NC II program.

**Table 7. Challenges Encountered by Automotive Students (n = 50)**

| Challenge | Yes (n) | Yes (%) | No (n) | No (%) | Remark |
|---|---|---|---|---|---|
| Insufficient access to tools and equipment | 43 | 86% | 7 | 14% | Highest-frequency challenge |
| Unavailability of automotive machines | 42 | 84% | 8 | 16% | Directly corroborates Table 1 findings |
| Time constraints during training | 36 | 72% | 14 | 28% | Reduces individual hands-on practice time |
| Overcrowded workshops | 34 | 68% | 16 | 32% | Tool-sharing reduces per-student practice |

| | | | | | |
|---|---|---|---|---|---|
| Inadequate instructor support | 5 | 10% | 45 | 90% | Not a primary constraint; institution's strength |

*Note. Percentages are rounded to the nearest whole number. Respondents could affirm or deny each challenge independently.*

The main difficulties reported by students in their automotive laboratory training were resource-related constraints. The two most common obstacles were the lack of access to tools and equipment (86%) and the lack of availability of automotive machines (84%). These findings are in line with the equipment condition and availability results shown in Table 1 and corroborate the positive relationship between the laboratory resources and students' self-rated technical skill development found in the correlation analysis. The high number of respondents who encounter these challenges shows that the unavailability of functional laboratory equipment is still a concern during practical training.

Furthermore, the major challenges were time constraints during the laboratory sessions (72%) and overcrowded workshops (68%). Such conditions may restrict students' opportunities to practice hands-on intensively, especially when many learners have to share the available equipment. Competency-based automotive education emphasizes the repeated performance of practical tasks. Limited laboratory time and access to equipment could limit the development of more advanced technical competencies.

On the other hand, only 10 percent of the respondents considered instructor support inadequate, and the majority (90 percent) felt that instructor guidance was adequate. The result shows that in general the instructional support is sufficient from the students' perspective. Respondents therefore appear to be experiencing difficulties more related to the availability of laboratory resources than to instructional guidance. The results indicate that the institution should make more efforts in improving laboratory facilities, purchasing more equipment, and optimizing the utilization of workshops to provide more opportunities for students' practical skills development.

## DISCUSSION

The results of the study showed that there is a positive and strong statistically significant relationship between availability of laboratory equipment and self-rated technical skill development of automotive students at Benguet State University–Bokod Campus. The Spearman rank-order correlation coefficient ($r\ s = 0.92$, $p < .01$) calculated for the eight paired skill areas shows that the increased availability of functional laboratory equipment correlates with increased levels of students perceived technical competence. This finding supports the premise that adequate laboratory resources are important to the development of practical automotive skills.

This observed association is consistent with the assumptions of Kolb's (1984) Experiential Learning Theory, which emphasizes that meaningful learning is the result of a continuous cycle of concrete experience, reflective observation, abstract conceptualization, and active experimentation. Students reported higher levels of competence in skills such as brake servicing, cooling system maintenance, and wheel alignment when they had access to functional equipment such as hand tools, power tools, and personal protective equipment (PPE). With these resources students were able to repeat laboratory activities, reflect on their experiences, and improve their technical performance through continual practice.

In contrast, competencies that required specialized diagnostic equipment had much lower self-rated proficiency. Skills such as operating an OBD-II scanner, diagnosing electrical systems, repairing air-conditioning, servicing transmissions, repairing powertrains, and operating hydraulic systems corresponded with equipment categories that were either unavailable or in poor condition. Students' lack of access to appropriate equipment limits their ability to engage in experiential learning and iterative experimentation and therefore limits the development of mastery of complex technical skills (Kolb's experiential learning theory).

The results are consistent with other studies in the world that have underlined the importance of lab resources in technical and vocational education. UNESCO (2016) observes that poor maintenance procedures and lack of equipment restrict people's ability to acquire new skills in Technical and Vocational Education and Training (TVET) institutions worldwide. Moreover, the study by Abdurrahman et al. (2022) showed that students in Indonesian vocational schools who were in a well-equipped car shop performed much better on the skills tests than the students who were in a less well-equipped car shop. Fah (2024) also found that functional training equipment was a significant indicator of the readiness of vocational students in Malaysian colleges for work and Amadi & Eniekenemi (2021) found that the quality of the workshop had a direct effect on the quality of practical skills learning of students in Nigerian technical colleges The strong positive association found in this study corroborates these international results and also gives specific details of the TVET environment in the Philippines.

In addition, the findings support a Philippine study on technical ability and educational resources. Anwar et al. (2023) found that automotive students who received less training in the workshop performed poorly on the job. Hence, availability of adequate laboratory apparatus was found to be a major factor that influenced the quality of education received by students who enrolled in automotive programs in public universities in the Bicol Region (Carpio, 2025). Yet, the differences in laboratory equipment were a significant factor that influenced the variations in students' performance across the technical-vocational-livelihood (TVL) schools in Batangas (Ramos, 2021). On the other hand, Alabar et al. (2025) found that laboratory facilities in some Philippine TVET institutions did not meet the standards required for students to acquire competency. The findings of the present study are consistent with the evidence. These studies indicate that laboratory resource constraints continue to be a significant problem in the technical-vocational education sector of the Philippines.

This study shows that there is a significant gap between the students' capability in basic mechanical skills and in technology-driven diagnostic skills, which is lower. However, this is consistent with the findings of Mutuku Ngulu et al. (2022) and Alabar et al. (2025) who stated that inadequate or outdated laboratory equipment has a negative effect on the development of higher technical skills. With the continuing evolution of the automotive industry towards electronically controlled, hybrid, and electric vehicle technologies, a lack of sufficient knowledge of modern diagnostic tools can prevent graduates from being ready for current industry demands. The knowledge of using OBD-II scanners, sensor diagnostics, and maintenance of electronically controlled engine systems has become a must for workforce preparedness in modern car servicing.

Within the limitations of the study, researchers should interpret the findings with caution, despite the strength of the observed association. The Spearman rank-order correlation was based on eight paired observations of skill areas and not on individual student-level data. This limits the precision and generalizability of the statistical result. In addition, students assessed their technical competency through self-assessments, which may be affected by self-perception and response bias.

Consequently, the reported association reflects the relationship between perceived competence and equipment availability rather than an objective measurement of performance. Modified laboratory equipment has proved effective in improving technical abilities in previous interventions such as Miranda et al. (2020) simulation-based training or Kerre et al. (2023) motorbike lifter technology transfer project. This effect was shown by applying previous interventions. Researchers suggest employing correlation, experimental, and longitudinal research designs to determine the causal relationship between the growth of technical competencies and the improvement of laboratory resources. The current investigation implicitly supports the association identified based on these data.

## Conclusions

This study examined the relationship between the state and availability of automotive laboratory equipment and the improvement of technical skills among students enrolled in the Automotive Servicing NC I and NC II programs. The findings indicate that the quality and availability of laboratory equipment have a significant effect on student’s perceived technical skills.

The results showed that hand tools, power tools, and personal protective equipment (PPE) were generally in good to excellent condition and suitable for routine laboratory work. Automotive machinery, on the other hand, was rated only fair because of deficiencies in the maintenance and functioning of specialized equipment needed for advanced automobile servicing competencies. It means that the institution has enough resources for basic practical tasks, but the complex of automotive equipment should be available and well maintained.

Students reported a high to moderate level of competence in mechanical skills that they commonly practiced using readily available laboratory equipment. However, they were less competent in technology-dependent diagnostic skills like using an OBD-II scanner, diagnosing electrical systems, repairing air conditioning, repairing transmission, repairing powertrain systems, and operating hydraulic systems. These competencies were related to equipment categories that were identified as having the lowest availability or poorest condition, which suggests that limited access to appropriate training resources may limit development of specialized technical skills.

Statistical analysis also revealed a positive, statistically significant strong correlation between equipment availability and students' self-rated development of technical skills ($r_s = 0.9226$, $p < .01$). The consistent pattern of positive association in all paired skill areas provides empirical evidence of better laboratory resources being associated with higher levels of perceived technical competence. Thus, the null hypothesis was rejected, which means that the availability of laboratory equipment has a significant relationship to the development of technical skills of students of Automotive Servicing NC I and NC II.

The major challenges to the students' learning experiences were resource-related constraints as well. Common barriers were lack of access to equipment, the limited availability of machines, time constraints during laboratory sessions, and overcrowded workshops. On the contrary, the instructor support was rated positively, which suggests that instructional guidance does not constitute the main problem. Instead, the findings suggest the need to build the institutional capacity for investing in laboratory facilities, acquisition and maintenance of equipment, and resource management to improve the quality of competency-based training.

The study concludes that the effectiveness of the Automotive Servicing NC I and NC II training is not only dependent on the quality of instructions but also on the adequacy, availability, and condition of laboratory equipment. Enhancing these physical learning resources is important to develop students' technical competencies, especially in specialized and technology-driven automotive servicing tasks. These findings offer important evidence to institutional administrators, technical-vocational educators, and policymakers to guide investments in strengthening competency-based automotive education and to prepare graduates for industry needs.

## Recommendations

Based on the findings and conclusions, the following recommendations are offered:

1. The university administration should make it a priority in its annual budgeting and development planning to acquire modern automotive diagnostic equipment, specifically engine analyzers, hydraulic lifts, OBD-II diagnostic scanners, and air conditioning service tools, to close the statistically identified competency gap in technology-dependent skill areas. The six competency categories highlighted in Table 6 as least developed should be the main focus of the investment procurement strategy.

2. An automotive laboratory must have a systematic preventive maintenance program that includes quarterly inspection cycles, documented maintenance logs, equipment condition assessment forms, and assigned personnel tasks. The program should be aimed at bringing the automotive machines from their current

fair state (WM = 2.31) to the good range and maintaining the machines in the good range, thereby providing equipment readiness for the entire academic year.

3. Restructure workshop scheduling to provide more individual hands-on practice time for each student, particularly for those areas of proficiency that are equipment-intensive. Rotations should be organized to provide equitable access to shared tools and machinery. Overcrowding limits could be resolved by staggered laboratory sessions or extra laboratory slots.

4. The institution should formalize and actively promote industry collaborations with auto dealerships, service centers, and repair shops to supplement laboratory resources through equipment loans, donated retired but functional machinery, joint training programs, or subsidized on-site industry immersion arrangements for students. These kinds of collaborations can allow the institution access to diagnostic equipment that it may not be able to afford right away.

5. To address the limitations of the self-rating bias in the present study, future research should utilize objective performance assessments such as direct observation using standardized competency checklists or TESDA-aligned performance tasks, in addition to self-report instruments. The individual-level Spearman or Pearson correlation analysis done on a larger, multi-campus sample would provide a more accurate measurement of the equipment-skill link. Experimental or longitudinal designs where the effect of specific equipment upgrades on measurable skill increases are assessed are also recommended to establish causal directionality.

## Compliance with Ethical Standards

The researcher states that this research followed the ethical standards laid down in the research involving human subjects. All participants gave written informed consent before participation**.** Respondents were explicitly informed that participation was voluntary and that they could withdraw from the study at any time without penalty or consequences. The anonymity and confidentiality of all respondents were strictly observed through all phases of data collection, processing, analysis, and reporting, in accordance with the applicable data privacy laws. The study protected the physical and psychological well-being of the respondents throughout the investigation. The researcher declares that there was no conflict of interest in the conduct or reporting of this work, that plagiarism was rigorously avoided, and that no bias was introduced in data collection, analysis, or interpretation. The study findings have been used only for academic and scholarly purposes. The researcher further notes that artificial intelligence technologies were not used in the design, data collection, analysis, or writing of the study.

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*johnreycorbe1@gmail.com*