



UTILIZATION OF LABORATORY EQUIPMENT IN FORENSIC SCIENCE SUBJECTS IN ENHANCING THE COMPETENCIES OF CRIMINOLOGY STUDENTS IN THE PROVINCE OF ALBAY; BASIS FOR INSTRUCTIONAL IMPROVEMENT

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ABSTRACT

This study examined the utilization of laboratory equipment in forensic science subjects and its impact on the competencies of criminology students in selected higher education institutions in the Province of Albay as a basis for instructional improvement. It specifically assessed the status of forensic laboratory equipment, evaluated its utilization in terms of functionality, ease of operation, and safety, determined its impact on students' competencies in practical skills, critical thinking, and application of forensic techniques, and identified implementation challenges. A descriptive mixed-methods design employing a convergent parallel approach was utilized. The respondents consisted of 264 participants (244 students and 20 instructors) from Amando Cope College, Bicol College, and PLT College of Guinobatan, Inc. Data were gathered through survey questionnaires, document analysis, and interviews and analyzed using weighted mean and thematic analysis. Findings revealed significant disparities in laboratory equipment availability and serviceability, with Bicol College demonstrating higher compliance with standards, Amando Cope College showing partial adequacy, and PLT College exhibiting notable deficiencies. Overall utilization was generally effective; however, inconsistencies in accessibility and ease of use were observed, along with

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perceptual differences between instructors and students. Results further indicated that laboratory equipment utilization positively influenced students' competencies, although variations existed across institutions. Identified challenges included inadequate facilities, outdated and insufficient equipment, operational delays, limited instructor competence, and weak laboratory management practices. Based on these findings, a Forensic Science Instructional Improvement Framework was developed to enhance laboratory instruction and strengthen competency development.

Key Words: *forensic laboratory equipment, utilization, criminology education, student competencies, instructional improvement*

INTRODUCTION

Education plays a vital role in preparing individuals for professional practice, particularly in fields that require both intellectual understanding and applied competence. In higher education, the development of practical skills is as important as theoretical knowledge, especially in disciplines involving technical and performance-based tasks. In criminology education, future professionals must be equipped not only with conceptual understanding of crime and justice but also with the ability to apply scientific methods in real-world criminal investigations.

In this regard, forensic science serves as a critical component of the criminal justice system, providing scientific approaches in the examination, analysis, and interpretation of

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physical evidence. It ensures accuracy, fairness, and credibility in criminal investigations and court proceedings. As crimes become more complex and technology-driven, the demand for competent forensic practitioners continues to grow, requiring educational institutions to strengthen the quality of forensic science instruction and training.

Globally, the importance of quality and relevant education is emphasized through Sustainable Development Goal 4 (Quality Education), one of the United Nations' 17 global goals for sustainable development. It aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. SDG 4 highlights not only access to education but also its quality, relevance, and inclusivity, ensuring that learners acquire the knowledge, skills, and values needed to thrive in a rapidly changing world. Ultimately, education is recognized as a key driver of development, poverty reduction, equality, and innovation. (United Nations, 2025). In line with this, there is a growing global demand for forensic science education that produces skilled professionals capable of responding to increasingly complex criminal challenges, requiring continuous investment in criminal justice and forensic training systems (Nilendu, 2024).

Forensic science is an applied discipline that uses scientific methods in the investigation of crimes and examination of evidence for legal purposes. It plays a vital role in supporting justice systems through objective and scientific analysis. In the Philippines, forensic science forms an important component of criminology education, where the Bachelor of Science in Criminology program focuses on crime, criminal behavior, and law enforcement. As prescribed by the Commission on Higher Education (CMO No. 21, s. 2005), criminalistics or forensic

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science is a major area of the program, emphasizing the development of competencies in scientific crime investigation and evidence handling.

The effective delivery of forensic science instruction requires laboratory-based learning, where students are given opportunities to apply theoretical concepts in practical and simulated environments. Laboratory training enhances students' technical skills, critical thinking, and preparedness for professional practice in law enforcement and forensic investigation (Espartero, 2022 as cited by Basalo, 2025). However, this learning approach depends heavily on the availability and proper utilization of laboratory equipment.

Despite its importance, forensic science instruction faces several challenges, including inadequate and outdated laboratory equipment, limited facilities, insufficient technical support, lack of trained instructors, and absence of qualified laboratory technicians (Remperaz and Calzada, 2025; Hiyan et al., 2025; Wekwe et al., 2025). In some cases, even when equipment is available, instructors may not be fully trained in its proper use, which further affects instructional effectiveness (Abas, 2020). These issues hinder students' ability to fully develop the competencies required under CHED standards, which emphasize that criminology graduates must possess scientific knowledge and skills in crime investigation, evidence analysis, and forensic application in fields such as questioned document examination, polygraphy, ballistics, photography, dactyloscopy, and toxicology (CMO No. 21, s. 2005).

In the Province of Albay, criminology programs experience similar challenges, including insufficient and outdated laboratory equipment, limited facilities, untrained instructors,

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shortage of qualified technicians, and delays in instructional implementation. These conditions hinder effective learning in forensic science, where practical application is essential. As a result, students struggle to bridge theory and practice, limiting their technical competence and confidence in performing forensic tasks required in real-world investigations.

Given these conditions, it is necessary to examine the utilization of forensic science laboratory equipment in enhancing the competencies of criminology students in the Province of Albay. This study will assess the status of laboratory equipment, its impact on students' competencies, and the challenges encountered by instructors in its utilization. The findings will serve as the basis for developing a Forensic Science Instructional Improvement Framework aimed at enhancing forensic science instruction.

This study is expected to benefit instructors through improved teaching strategies, administrators through identification of resource and instructional gaps, and students through enhanced practical competencies and preparedness for criminal justice careers. Ultimately, it seeks to contribute to the production of competent and skilled forensic science graduates.

MATERIALS AND METHODS

This study utilized a mixed methods research design, combining quantitative and qualitative approaches to obtain a comprehensive understanding of the subject under investigation.

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Mixed methods research combines elements of quantitative research and qualitative research in order to answer your research question. Mixed methods can help you gain a more complete picture than a standalone quantitative or qualitative study, as it integrates benefits of both methods (Tegan, 2021). Mixed methods research is particularly useful when a research question requires multifaceted approach that can simultaneously explore trends in data and the nuances of individual experiences (McLeod, 2024).

This study employed a mixed methods research design as it is suited to comprehensively examine the utilization of laboratory equipment in forensic science subjects and its role in enhancing the competencies of criminology students. The use of both quantitative and qualitative approaches enabled the study to capture measurable aspects of equipment utilization and competency development, while also exploring deeper insights into existing challenges and contextual factors influencing the teaching and learning process. Through the integration of these approaches, the study was able to generate a more holistic understanding of the research problem, thereby providing a stronger basis for instructional improvement.

The study was conducted in three higher education institutions in the Province of Albay, Philippines, namely Amando Cope College, Bicol College, and PLT College of Guinobatan, Inc., all offering the Bachelor of Science in Criminology program with forensic science components. The respondents totaled 264, composed of 244 fourth-year criminology students and 20 criminology instructors. Student respondents were selected through simple random sampling (Thomas, 2023), while all instructors teaching forensic science subjects were

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included through total enumeration (Christon, 2024). For the qualitative phase, nine (9) instructors were purposively selected based on a minimum of two (2) years teaching experience in forensic science subjects (Hassan, 2024), distributed as one (1) from Amando Cope College, six (6) from Bicol College, and two (2) from PLT College of Guinobatan, Inc.

Data collection utilized a structured questionnaire and a semi-structured interview guide. The questionnaire measured laboratory equipment utilization in terms of functionality, ease of operation, and safety, as well as its impact on students' competency development in practical skills, critical thinking, and application of forensic techniques (Hassan, 2025). The interview guide was used to gather qualitative data on challenges encountered in laboratory instruction and equipment utilization (Panyasai & Ambele, 2025). Both instruments underwent validation through adviser review, panel evaluation, and external expert assessment to ensure content validity, clarity, and alignment with research objectives.

Following approval of the research title, instrument validation was conducted, and revisions were incorporated based on recommendations from the adviser, panel members, and external expert. Formal permission to conduct the study was obtained from the participating institutions through approved communication letters. Informed consent was secured from all respondents, ensuring voluntary participation, confidentiality, and ethical compliance. Survey questionnaires were personally distributed and retrieved after one week, while face-to-face interviews were conducted within the same period. The entire data gathering process was completed within three weeks. Collected survey data were prepared for statistical treatment, while interview responses were organized for qualitative analysis.

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Data analysis involved document analysis, weighted mean, and thematic analysis.

Document analysis was used to examine laboratory inventories, institutional records, and related documents to determine the status of laboratory equipment used in forensic science subjects (Hassan, 2024). Weighted mean was used to determine the level of laboratory equipment utilization and its impact on students' competencies (Gatapia, 2025).

Thematic analysis was used to identify patterns in qualitative responses through systematic coding, categorization, and theme development (Naeem et al., 2023).

RESULTS AND DISCUSSION

This section presents the results and discussion of the findings regarding the status of laboratory equipment used in forensic photography, personal identification techniques, forensic chemistry, questioned document examination, forensic ballistics, and lie detection techniques. It also examines the utilization of this equipment in terms of functionality, ease of operation, and safety, as well as its impact on students' competency and development, including practical skills acquisition, critical thinking, and the application of forensic science techniques. The study focuses on three institutions: Amando Cope College, Bicol College, and PLT College of Guinobatan, Inc.

1. Status of laboratory equipment

This section presents the status of laboratory equipment used in forensic photography, Personal Identification Techniques, Forensic Chemistry, Questioned Document Examination, Forensic Ballistics, and Lie Detection Techniques across three institutions, namely Amando

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 Cope College, Bicol College, and PLT College of Guinobatan, Inc., in comparison with the required quantities prescribed by CHED. The tables below show the availability, quantity, and serviceability of essential tools and equipment necessary for laboratory-based learning.

a. Forensic Photography

The table presents the status of laboratory equipment used in forensic photography across Amando Cope College, Bicol College, and PLT College of Guinobatan, Inc., in terms of availability, quantity, and serviceability.

Table 1.a

Forensic Photography

Forensic Subject	Laboratory Equipment	AMANDO COPE		BICOL COLLEGE		PLT COLLEGE OF GUINOBATAN, INC.	
		Quantity	Status	Quantity	Status	Quantity	Status
FORENSIC PHOTOGRAPHY	Camera 35mm with tripod and accessories	1	serviceable	0	-	0	-
	Cameras 4x5 with stand and accessories	0	-	0	-	0	-
	Dryer	1	serviceable	1	serviceable	0	-
	Enlarger (Projection)	1	serviceable	2	serviceable	1	serviceable
	Contact Printer	0	-	0	-	0	-
	Cutter	1	serviceable		serviceable	0	-
	Timer	1	serviceable	6	serviceable	0	-
	120 mm camera	0	-	0	-	0	-
	Reels – 1 – Stainless; 1 Pc – 120mm	1	serviceable	0	-	0	-
	Reels – 135 mm	1	serviceable	2	serviceable	0	-
	Developing tanks	1	serviceable	7	5 serviceable	0	-
Trays for developing and fixing	1	serviceable	6	serviceable	0	-	

Amando Cope College demonstrates partial compliance with CHED requirements for forensic photography equipment. While some essential tools such as the 35mm camera, enlarger, contact printer, cutter, timer, reels, and trays are present, many are only minimally

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available and limited in quantity. Notably, most equipment is marked as serviceable, indicating that despite the insufficiency in number, the existing tools are functional. However, gaps are evident in critical items such as the 120 mm camera and developing tanks, where availability does not meet the required standard.

Bicol College shows relatively better provision of forensic photography equipment compared to the other institutions. Several items, including the enlarger, dryer, timer, developing tanks, and trays, exceed or meet the required quantities, and most are in serviceable condition. This indicates a stronger institutional investment in laboratory resources. However, some equipment such as cameras and contact printers remain unavailable or insufficient.

PLT College of Guinobatan, Inc. reflects a significant lack of forensic photography laboratory equipment. Most items listed in the CHED requirements are either unavailable or recorded as zero in quantity. Only a few pieces of equipment, such as the enlarger, are present and serviceable, but these are insufficient relative to the required standards.

The findings reveal a notable disparity in the availability, adequacy, and standard compliance of forensic photography laboratory equipment among the three institutions. While Bicol College demonstrates relatively stronger alignment with CHED requirements, Amando Cope College reflects partial compliance characterized by limited quantities despite the serviceability of available equipment, and PLT College of Guinobatan, Inc. shows significant deficiencies in both availability and completeness of required tools.

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Such variation suggests that institutional capacity and resource allocation play a critical role in shaping laboratory preparedness, which in turn influences the consistency of forensic science instruction. The uneven provision of essential equipment limits uniform exposure to practical laboratory experiences, thereby affecting the extent to which students can fully develop and integrate forensic competencies within academic and applied contexts. This highlights the need for institutional investment in laboratory facilities, strategic resource allocation, and continuous monitoring to ensure equitable and competency-based training in forensic photography.

Proper photographic tools are essential for accurate documentation and reliable forensic practice, indicating that institutions with better equipment are more capable of delivering quality instruction (Ray, 2024). Likewise, hands-on training using cameras and imaging tools is crucial in developing students' competencies, reinforcing that limited equipment restricts practical learning opportunities (Plotkin, 2026). Furthermore, acquiring essential forensic photography equipment remains a challenge in developing contexts, which significantly affects laboratory capability and instructional effectiveness (Howes et al., 2024).

b. Personal identification techniques

The table presents the status of laboratory equipment used in Forensic Chemistry across Amando Cope College, Bicol College, and PLT College of Guinobatan, Inc., in terms of availability, quantity, and serviceability, providing a comparative assessment of the extent to which each institution complies with CHED requirements for effective laboratory-based instruction in forensic chemistry.

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Table 1. b

Personal Identification Techniques

Forensic Subject	Laboratory Equipment	AMANDO COPE		BICOL COLLEGE		PLT COLLEGE OF GUINOBATAN, INC.	
		Quantity	Status	Quantity	Status	Quantity	Status
PERSONAL IDENTIFICATION TECHNIQUES	Magnifying glasses	56	serviceable	67	Serviceable 40 for exhibit	25	serviceable
	Fingerprint brushes	0	-	25	serviceable	10	serviceable
	Fingerprint rollers	0	-	7	serviceable	10	serviceable
	Glass slabs	0	-	10	serviceable	20	serviceable
	Fingerprint cameras	2	Serviceable	0	-	0	-
	Horseshoe fingerprint lens for classification	6	Serviceable	7	serviceable	0	-
	Fingerprint pointers	8	Serviceable	5	serviceable	0	-
	Lifting tape	6	Serviceable	6	serviceable	1	serviceable
	Fingerprint Mounters	8	Serviceable	7	serviceable	-	0
	Fingerprint tables	6	Serviceable	1	serviceable	1	serviceable
	Fingerprint ink	8	Serviceable	2	serviceable	1	serviceable
	Fingerprint cards of chart	0	-	0	-	5	serviceable
	Fingerprint powder of different colors	0	-	49	serviceable	2	serviceable

Amando Cope College demonstrates moderate compliance with CHED requirements for laboratory equipment in personal identification techniques. The institution exceeds the required quantity in several tools such as magnifying glasses, fingerprint pointers, lifting tape, and fingerprint mountings, all of which are reported as serviceable. However, there are notable deficiencies in key items such as fingerprint brushes, rollers, glass slabs, and ink, which are completely unavailable. While some specialized equipment like fingerprint cameras and classification lenses meet the required standards and are functional, the absence of fundamental tools may limit the effectiveness of fingerprint development and analysis activities.

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Bicol College presents a mixed level of compliance. While the institution has a sufficient number of certain materials such as fingerprint powder of different colors and classification lenses, some equipment is either insufficient or not serviceable. For instance, fingerprint brushes are available but marked as unserviceable, which directly affects their usability in laboratory activities. Additionally, several items such as fingerprint cameras and chart cards are unavailable. Despite having some equipment in excess of requirements, inconsistencies in serviceability and availability may hinder the continuity and quality of practical exercises.

PLT College of Guinobatan, Inc. shows limited compliance with CHED standards. While some equipment such as magnifying glasses, fingerprint brushes, rollers, and ink are available and serviceable, most specialized tools including fingerprint cameras, classification lenses, and pointers are absent. The quantities of available equipment are also generally below the required levels.

The findings reveal that the three institutions are not fully aligned with CHED standards in terms of laboratory equipment for personal identification techniques, with varying degrees of compliance observed across Amando Cope College, Bicol College, and PLT College of Guinobatan, Inc. The inconsistencies in availability, quantity, and serviceability of essential tools indicate uneven institutional capacity in supporting laboratory-based forensic instruction.

These gaps suggest that deficiencies in both the provision of fundamental and specialized equipment may constrain the effectiveness of hands-on training, particularly in fingerprint development and analysis activities, which are central to personal identification

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techniques. These conditions have direct implications on the quality of laboratory instruction and skill acquisition among criminology students. The lack of complete and functional equipment may restrict hands-on learning opportunities, reduce students' exposure to standard forensic procedures, and ultimately affect their competency in personal identification techniques. Therefore, it is imperative for institutions to prioritize the procurement, maintenance, and upgrading of laboratory equipment to ensure effective and competency-based forensic education.

This implication is supported by literature emphasizing the necessity of advanced and functional forensic laboratory systems. Advanced DNA-based identification systems require resource-intensive laboratory environments to ensure reliability and accuracy (Alketbi, 2024). Similarly, advanced instruments such as mass parallel sequencing and bioinformatics platforms are essential for expanding identification capabilities in modern forensic practice (Kayser et al., 2023). Moreover, PCR- and STR-based profiling depend on well-equipped laboratories and trained personnel to ensure precise results (Sauvagère, 2023). In the Philippine context, limited access to DNA analyzers, reagents, and adequate laboratory space has been identified as a factor that delays forensic processing in academic and institutional settings (Bautista, 2024). Likewise, inadequate forensic laboratories in academic institutions significantly restrict students' practical exposure and competency development (Benter, 2021).

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c. Lie Detection Techniques

The table presents the status of laboratory equipment used in Lie Detection Techniques across Amando Cope College, Bicol College, and PLT College of Guinobatan, Inc., in terms of availability, quantity, and serviceability. It further examines the extent to which these resources support the conduct of practical exercises and skill development in lie detection procedures.

Table 1. c

Lie Detection Techniques

Forensic Subject	Laboratory Equipment	AMANDO COPE		BICOL COLLEGE		PLT COLLEGE OF GUINOBATAN, INC.	
		Quantity	Status	Quantity	Status	Quantity	Status
LIE DETECTION	Polygraph machine	2	serviceable	2	1 For exhibit 1 serviceable	1	serviceable

Amando Cope College exceeds the CHED-required quantity for polygraph machines, having two units, both of which are reported as serviceable. Bicol College also exceeds the minimum requirement in terms of quantity, possessing two polygraph machines. However, only one unit is serviceable, while the other is designated "for exhibit." Lastly, PLT College of Guinobatan, Inc. meets the CHED requirement by having one polygraph machine, which is reported as serviceable.

The findings reveal that while all three institutions meet or exceed the CHED requirement for polygraph machines, there are notable variations in functionality and

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adequacy that affect their instructional utility. Amando Cope College demonstrates a higher level of readiness due to the availability of multiple serviceable units, which enhances opportunities for hands-on training and repeated practice. In contrast, Bicol College, despite having sufficient quantity, is constrained by the limited functionality of one unit, reducing its overall effectiveness for practical instruction. PLT College of Guinobatan, Inc., while compliant with the minimum requirement, may have limited capacity to provide extensive experiential learning due to the presence of only a single unit.

These variations suggest that while basic competency in lie detection techniques can be achieved, the depth and quality of skill development may differ across institutions. These conditions imply that compliance in terms of quantity does not necessarily reflect instructional sufficiency, as the functionality and accessibility of equipment significantly influence the quality of laboratory-based learning experiences in Lie Detection Techniques. Therefore, compliance should not be limited to quantity alone but must also ensure the maintenance and full operational functionality of equipment to maximize learning outcomes and enhance student competencies in lie detection techniques.

This implication is supported by literature emphasizing that limitations in equipment quality, calibration, and analytical systems significantly affect the accuracy and reliability of polygraph results (Shalash et al., 2025). In addition, criminology training environments often rely on basic or limited tools, which restrict opportunities for practical skill development (Gacuyaon, 2022). Furthermore, advanced lie detection systems require specialized equipment and controlled environments that are frequently unavailable in academic

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institutions, reinforcing how resource constraints directly impact both training quality and competency development in forensic instruction (Taha et al., 2025).

d. Forensic Chemistry

The table presents the status of laboratory equipment used in Forensic Chemistry across Amando Cope College, Bicol College, and PLT College of Guinobatan, Inc., in terms of availability, quantity, and serviceability.

Table 1.c
Forensic Chemistry

Forensic Subject	Laboratory Equipment	AMANDO COPE		BICOL COLLEGE		PLT COLLEGE OF GUINOBATAN, INC.	
		Quantity	Status	Quantity	Status	Quantity	Status
FORENSIC CHEMISTRY	Test tube 30mm	1	serviceable	10	serviceable	5	serviceable
	Test tube holder	1	serviceable	1	serviceable	1	serviceable
	Test tube rack	1	Serviceable	1	Serviceable	1	serviceable
	Erlenmeyer Flask, 250ml	1	Serviceable	1	Serviceable	1	Serviceable
	Funnel 75 ml	1	Serviceable	1	Serviceable	1	Serviceable
	Evaporating Dish 75 mm	1	Serviceable	1	Serviceable	1	Serviceable
	Bunsen Burner	1	serviceable	1	serviceable	1	Serviceable
	Graduated Cylinder 50 ml	1	Serviceable	1	Serviceable	1	serviceable
	Beaker 600 ml	1	Serviceable	1	Serviceable	1	Serviceable
	Beaker 400 ml	1	Serviceable	1	Serviceable	1	Serviceable
	Beaker 250 ml	1	serviceable	1	serviceable	1	Serviceable
	Beaker 100 ml	1	serviceable	1	serviceable	1	serviceable
	Calcium Chloride Tube	1	serviceable	1	serviceable	1	serviceable
	Clay Triangle	1	serviceable	1	serviceable	1	serviceable
	Cobalt Glass	1	serviceable	1	serviceable	1	serviceable
	Crucible and Cover	1	serviceable	1	serviceable	1	serviceable
	Crucible Tong	1	serviceable	1	serviceable	1	serviceable
	Florence Flask 1000 ml	1	serviceable	1	serviceable	1	serviceable
	Iron clamp	1	serviceable	1	serviceable	1	serviceable
	Mortar and pestle	1	serviceable	1	Serviceable	1	serviceable
	Reagent bottle 500 ml	1	serviceable	1	Serviceable	1	serviceable
	Burette Acid 100 ml	1	serviceable	1	Serviceable	1	serviceable
	Burette Alkali 100 ml	1	serviceable	1	Serviceable	1	serviceable
Burette Clamp	1	serviceable	1	serviceable	1	serviceable	

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Amando Cope College demonstrates high compliance with CHED requirements for forensic chemistry laboratory equipment. Almost all listed apparatus, including test tube holders, racks, flasks, funnels, burners, beakers, and other essential tools, are available in the required quantity and are serviceable. However, a notable deficiency is observed in the number of test tubes (30 mm), where only one unit is available compared to the required ten.

Bicol College fully complies with the CHED requirements for forensic chemistry equipment. All listed laboratory apparatus are available in the required quantities and are reported as serviceable. PLT College of Guinobatan, Inc. also demonstrates substantial compliance with CHED standards, with most laboratory equipment available and serviceable. Similar to the other institutions, all essential apparatus are present and functional. However, like Amando Cope College, the institution has a deficiency in the number of test tubes, with only five units available instead of the required ten.

The findings reveal that all three institutions demonstrate generally strong compliance with CHED requirements for forensic chemistry laboratory equipment in terms of availability and serviceability, with only minor variations observed across specific items. Bicol College reflects full compliance, as all listed apparatus are present in the required quantities and are functional. Amando Cope College and PLT College of Guinobatan, Inc. both exhibit high levels of compliance; however, they share a common deficiency in the availability of test tubes, which fall below the prescribed standard despite the functionality of other equipment.

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These conditions suggest that while laboratory resources are largely adequate to support instructional activities, minor shortages in essential consumables may still influence the efficiency and scalability of laboratory exercises. In particular, limitations in commonly used items such as test tubes may restrict simultaneous participation among students during experiments, thereby affecting the overall flow and optimization of hands-on learning in forensic chemistry. The adequacy of equipment in forensic chemistry suggests that students are generally provided with sufficient opportunities to develop essential laboratory skills. Nevertheless, institutions should address these minor shortages and ensure the continuous maintenance of laboratory equipment to further optimize learning experiences and strengthen competency development in forensic chemical analysis.

This implication is supported by literature emphasizing that insufficient laboratory capacity and resources can lead to operational delays and reduced efficiency in scientific training environments (Miller et al., 2022). Furthermore, continuous investment in laboratory instrumentation and supporting resources is necessary to keep pace with evolving forensic demands, highlighting that even minor resource gaps can influence overall laboratory performance and instructional effectiveness (McAndrew, 2023).

e. Questioned Document Examination

The table presents the status of laboratory equipment used in Questioned Document Examination across Amando Cope College, Bicol College, and PLT College of Guinobatan, Inc., in terms of availability, quantity, and serviceability. It also highlights institutional variations

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that may affect the development of students' technical skills and accuracy in forensic document examination.

Table 1. e

Questioned Document Examination

Forensic Subject	Laboratory Equipment	AMANDO COPE		BICOL COLLEGE		PLT COLLEGE OF GUINOBATAN, INC.	
		Quantity	Status	Quantity	Status	Quantity	Status
QUESTIONED DOCUMENT	Picca test plates	2	Serviceable	3	Serviceable	0	-
	Elite test plates	0	-	3	serviceable	0	-
	Typewriting protractor	2	Serviceable	3	serviceable	0	-
	Space test plates	1	Serviceable	3	serviceable	0	-
	Camera, 35 mm for questioned document with stand	1	Serviceable	0	-	0	-
	Stereoscopic microscopes	1	Serviceable	0	-	0	-
	Enlarger	0	-	0	-	1	Serviceable
	Dyer	0	-	1	For exhibit	0	-
	Paper Cutter	1	Serviceable	0	-	1	-
	Ultraviolet Rays Machine	1	Serviceable	3	For exhibit	1	serviceable
	Infrared rays Machine	0	-	1	serviceable	1	For exhibit

Amando Cope College demonstrates moderate compliance with CHED requirements for questioned document laboratory equipment. Several essential tools such as Picca test plates, typewriting protractor, stereoscopic microscopes, ultraviolet rays machine, and paper cutter are available and serviceable. However, some equipment such as elite test plates, enlarger, dyer, and infrared rays machine are either unavailable or lacking.

Bicol College shows relatively strong compliance in terms of quantity, as several pieces of equipment such as Picca test plates, elite test plates, typewriting protractor, and space test plates exceed the CHED required number. Additionally, the ultraviolet and infrared rays machines are available. However, a number of these are labeled "for exhibit," indicating that

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they may not be fully operational or intended for demonstration rather than hands-on use.

Furthermore, essential tools such as the 35mm camera, stereoscopic microscopes, and paper cutter are unavailable.

PLT College of Guinobatan, Inc. reflects limited compliance with CHED standards. Most required equipment, including test plates, typewriting protractor, camera, stereoscopic microscopes, and dyer, are unavailable. Only a few tools such as the enlarger and ultraviolet rays machine are present, with the latter being serviceable. The infrared rays machine is available but designated "for exhibit," indicating limited usability.

The findings reveal notable disparities in both the availability and functional usability of questioned document laboratory equipment among the three institutions, reflecting varying levels of compliance with CHED standards. Bicol College demonstrates relatively stronger compliance in terms of quantity, as several equipment items meet or exceed requirements; however, the usability of some tools is constrained due to their designation for exhibit purposes, which limits their application in hands-on laboratory activities. Amando Cope College shows partial adequacy, with several core instruments available and serviceable, though gaps remain in the provision of specialized equipment. In contrast, PLT College of Guinobatan, Inc. exhibits significant deficiencies, with most required tools unavailable and only a minimal number of functional equipment present.

These conditions suggest that compliance in terms of equipment provision does not necessarily translate to effective instructional utility, as the functionality and accessibility of

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laboratory tools critically influence the quality of forensic document examination training. The variations across institutions indicate uneven capacity to support experiential learning, particularly in developing technical proficiency in questioned document analysis. These limitations have direct implications on students' ability to perform hands-on document analysis, which is essential in developing competencies in forensic examination. The lack of complete and functional equipment may hinder skill acquisition, critical thinking, and the practical application of theoretical knowledge. Therefore, institutions must prioritize not only the acquisition but also the maintenance and operational readiness of laboratory equipment to ensure effective and competency-based instruction in questioned document examination.

This implication is supported by literature emphasizing the necessity of specialized tools for effective forensic document analysis. Essential instruments such as video spectral comparators, advanced lighting systems, and electrostatic detection apparatus (ESDA) machines are required for comprehensive examination; however, their availability is often constrained by funding limitations (Mercado, 2025). Moreover, questioned document examination relies on highly technical procedures that require both appropriate equipment and qualified personnel to ensure accuracy and reliability (Philippine National Police, 2021). In addition, disparities in access to advanced instrumentation and laboratory resources have been shown to directly affect the accuracy, efficiency, and reliability of forensic document examination outcomes (Deviterne-Lapeyre, 2023).

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f. Forensic Ballistics

The table presents the status of laboratory equipment used in Forensic Ballistics across Amando Cope College, Bicol College, and PLT College of Guinobatan, Inc., in terms of availability, quantity, and serviceability. It further evaluates how these resources facilitate the conduct of ballistic examinations, including firearm identification and trajectory analysis. Additionally, this section identifies institutional differences that may influence the development of students' technical proficiency

Table 1.f

Forensic Ballistics

Forensic Subject	Laboratory Equipment	AMANDO COPE		BICOL COLLEGE		PLT COLLEGE OF GUINOBATAN, INC.	
		Quantity	Status	Quantity	Status	Quantity	Status
FORENSIC BALLISTICS	Bullet comparison microscope	2	Serviceable	2	serviceable	1	serviceable
	Stereoscopic microscope	1	Serviceable	1	serviceable	0	-
	Shadowgraph	1	Serviceable	1	serviceable	0	-
	Bullet recovery box	1	Serviceable	0	-	1	Serviceable
	Analytical Balance	1	Serviceable	1	serviceable	0	-
	Revolvers	1	Serviceable	0	-	0	-
	Shotgun	0	-	0	-	0	-
	Rifle	0	-	0	-	0	-
	Camera (120mm)	0	-	0	-	0	-
	Ammunition file	1	Serviceable	1	complete	1	Serviceable
	Taper gauges	2	Serviceable	2	complete	2	Serviceable
	Caliper	2	Serviceable	3	serviceable	2	Serviceable
	Drawing instruments	0	-	1	serviceable	0	-
	Trigger pull measuring device	1	serviceable	1	serviceable	0	-

Amando Cope College demonstrates relatively strong compliance with CHED requirements for forensic ballistics equipment. Most of the essential instruments, such as the bullet comparison microscope, stereoscopic microscope, shadowgraph, bullet recovery box, analytical balance, ammunition file, taper gauges, caliper, and trigger pull measuring device,

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are available and reported as serviceable. In some cases, such as the bullet comparison microscope, the quantity exceeds the required minimum, indicating adequate provision for student use. However, the institution lacks critical firearms such as shotguns and rifles, as well as supporting equipment like the 120mm camera and drawing instruments. Although the presence of key analytical tools supports laboratory instruction, the absence of actual firearms limits students' exposure to real-world ballistic handling and examination.

Bicol College also shows a high level of compliance in terms of laboratory equipment availability. Most instruments, including the bullet comparison microscope, stereoscopic microscope, shadowgraph, analytical balance, and trigger pull measuring device, are present and serviceable. Additionally, some tools such as calipers exceed the required quantity, suggesting sufficient resources for laboratory activities. However, similar to Amando Cope College, Bicol College lacks essential firearms such as revolvers, shotguns, and rifles. The absence of a bullet recovery box is also notable.

PLT College of Guinobatan, Inc. shows partial compliance with CHED standards. The institution has several basic and essential tools such as the bullet comparison microscope, bullet recovery box, ammunition file, taper gauges, and calipers, all of which are serviceable. However, many critical instruments including stereoscopic microscope, shadowgraph, analytical balance, trigger pull measuring device, and drawing instruments are unavailable. Similar to the other institutions, firearms such as revolvers, shotguns, and rifles are also absent.

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The findings reveal that while Amando Cope College and Bicol College demonstrate relatively higher compliance with CHED requirements in terms of analytical and measurement instruments, all three institutions still exhibit significant deficiencies in firearm-related equipment essential for comprehensive forensic ballistics instruction. Although most laboratory tools such as comparison microscopes, calipers, and other measuring devices are available and serviceable, the consistent absence of critical firearms (such as revolvers, shotguns, and rifles) across all institutions reflects a major gap in the completeness of laboratory resources. PLT College of Guinobatan, Inc. further shows limitations in both specialized instruments and supporting equipment, indicating a lower level of readiness for advanced ballistic analysis activities.

These conditions suggest that compliance is largely concentrated on analytical apparatus rather than on actual field-relevant tools, resulting in an imbalance between theoretical laboratory analysis and practical firearm examination. The lack of firearms and other key instruments restricts the scope of laboratory instruction, thereby limiting students' opportunities to engage in authentic ballistic analysis and firearm identification procedures. These limitations may hinder the development of essential competencies required in forensic ballistics. Therefore, it is imperative for institutions to invest in comprehensive laboratory resources, particularly in acquiring regulated firearm equipment and maintaining existing tools, to ensure that students receive complete and competency based training aligned with professional forensic standards.

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This implication is supported by literature emphasizing the critical role of advanced forensic ballistic systems and equipment in ensuring accurate analysis. The Integrated Ballistics Identification System (IBIS) enables the digital capture and comparison of ballistic evidence; however, it requires advanced hardware, software, trained personnel, and continuous maintenance to function effectively (Centre of Forensic Sciences, 2022). In addition, studies indicate that outdated equipment, staffing shortages, and limited access to automated systems contribute to inefficiencies in firearm evidence analysis, which may compromise the quality and reliability of forensic outcomes.

2. Utilization of Laboratory Equipment in Forensic Science Subjects

This presents the utilization of laboratory equipment in forensic science subjects among 4th-year criminology students and instructors at Amando Cope College, Bicol College, and PLT College of Guinobatan, Inc., focusing on functionality, ease of operation, and safety.

a. Functionality

This section presents the functionality of laboratory equipment used in forensic science subjects among fourth-year criminology students and instructors at Amando Cope College, Bicol College, and PLT College of Guinobatan, Inc., focusing on the extent to which the equipment is operational, effective, and suitable for use in laboratory-based instruction.

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Table 2.a

Functionality

Indicators	Amando Cope College		Bicol College		PLTCGI		Average Weighted Mean		Adjectival Interpretation							
	Instructors	Students	Instructors	Students	Instructors	Students	Instructors	Students	Instructors	Students						
1. Performs intended forensic tasks accurately.	3.25	A	2.68	A	2.45	D	3.28	SA	3.67	SA	3.62	SA	3.52	3.19	A	A
2. Delivers consistent results during repeated use.	4.00	SA	3.02	A	2.82	A	3.31	SA	4.00	SA	3.62	SA	3.61	3.32	SA	SA
3. Supports multiple forensic applications (e.g., comparison microscope can be used in ballistics, fingerprint identification and forensic chemistry and toxicology).	4.00	SA	3.05	A	2.54	A	3.39	SA	4.00	SA	3.55	SA	3.51	3.33	SA	SA
4. Operates without frequent breakdowns or malfunctions.	3.75	SA	2.77	A	2.46	D	3.26	A	3.00	SA	3.59	SA	3.07	3.32	A	A
5. Features are appropriate for instructional purposes.	4.00	SA	2.93	A	2.63	A	3.32	SA	4.00	SA	3.59	SA	3.54	3.28	SA	S A
6. Matches the specifications required for the subject/course.	4.00	SA	3.02	A	2.83	A	3.37	SA	4.00	SA	3.59	SA	3.61	3.33	SA	SA
7. Contributes effectively to practical student exercises.	3.75	SA	3.14	A	2.54	A	3.37	SA	3.67	SA	3.59	SA	3.65	3.37	SA	SA
8. Reliable during demonstrations and hands-on activities.	3.75	SA	2.93	A	2.64	A	3.36	SA	4.00	SA	3.56	SA	3.46	3.28	SA	SA
9. Produces outputs that meet industry or academic standards.	3.75	SA	2.93	A	2.54	A	3.40	SA	4.00	SA	3.54	SA	3.43	3.29	SA	SA
10. Allows integration with software or digital tools when needed.	2.00	D	2.75	A	2.90	A	3.27	SA	2.67	A	3.63	SA	2.52	3.22	A	A
Average	3.62	SA	2.94	A	2.64	A	3.33	SA	3.70	SA	3.59	SA	3.32	3.29	SA	SA

Legend: 3.28-4.00 (Strongly Agree) 2.52-3.27 (Agree) 1.76-2.51 (Disagree) 1.00-1.75 (Strongly disagree)

The findings for Amando Cope College reveal that instructors generally rated the functionality of laboratory equipment higher than students, with most indicators interpreted as “Strongly Agree,” particularly in performing intended forensic tasks accurately (3.25), supporting multiple forensic applications (4.00), and matching subject objectives (4.00). However, student ratings are comparatively lower, mostly within the “Agree” range, with notable declines in indicators such as integration with digital tools (2.75, interpreted as “Disagree”) and production of outputs meeting standards (2.93). Overall, the functionality is moderate but reveals gaps between instructional intent and student experience.

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Bicol College presents relatively lower functionality ratings compared to the other institutions, with most indicators interpreted as “Agree” but with some variability between instructors and students. Instructors rated several indicators moderately high, such as performing tasks accurately (3.28) and facilitating demonstrations (4.00), indicating a perception of adequacy. However, student ratings tend to be slightly lower, particularly in operational efficiency (3.00), integration with digital tools (2.87), and production of outputs (3.54).

PLT College of Guinobatan, Inc. demonstrates consistently high functionality ratings from both instructors and students, with most indicators interpreted as “Strongly Agree.” Instructors rated all indicators at the highest level (mostly 4.00), reflecting strong confidence in the equipment’s ability to perform accurate forensic tasks, support various applications, facilitate demonstrations, and produce quality outputs. Student responses also align closely, with ratings predominantly in the “Agree” to “Strongly Agree” range, particularly in supporting forensic applications (3.54), contributing to exercises (3.67), and enabling demonstrations (4.00). Although slightly lower than instructor ratings, student responses still indicate a high level of satisfaction and usability. Even in areas such as integration with digital tools (3.27), the ratings remain positive.

The results reveal that the functionality of laboratory equipment plays a critical role in shaping the practical competencies of criminology students. Institutions with higher functionality levels, such as PLT College, are better positioned to deliver effective, hands-on forensic education that reinforces theoretical knowledge through practical application. In

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contrast, discrepancies between instructor and student perceptions, as observed in Amando Cope College and Bicol College, indicate potential gaps in accessibility, usability, or technological relevance of equipment.

These gaps imply that differences in perceived functionality may hinder students' ability to fully develop essential forensic skills and reflect uneven hands-on exposure or varying effectiveness in translating instructional intent into student experience. Such inconsistencies may hinder students' ability to fully develop essential forensic competencies, particularly in applying theoretical knowledge to practical laboratory tasks.

The findings confirm that the functionality of laboratory equipment is a critical determinant of criminology students' practical competencies in forensic science. This aligns with Nilendu (2024), who emphasized that learning outcomes improve when students actively engage with functional tools that simulate real forensic tasks, as seen in institutions like PLT College where higher functionality supports effective hands-on learning. In contrast, the discrepancies between instructor and student perceptions in Amando Cope College and Bicol College suggest issues in accessibility, usability, or relevance, consistent with Binalon (2025), who found that inadequate and poorly maintained equipment limits competency development. Although virtual and blended laboratories, as noted by Medina (2024) and Haberbosch et al. (2025), can enhance conceptual understanding and engagement, they cannot fully replace actual laboratory experience. As emphasized by Sebulan (2024), direct interaction with functional forensic instruments remains essential for developing technical skills and

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instructional effectiveness, reinforcing that equipment functionality is a key factor in achieving quality forensic education.

b. Ease of Operation

This section presents the ease of operation of laboratory equipment used in forensic science subjects among fourth-year criminology students and instructors at Amando Cope College, Bicol College, and PLT College of Guinobatan, Inc.

Table 2.b
Ease of Operation

Indicators	Amando Cope College		Bicol College		PLTCGI		Average Weighted Mean		Adjectival Interpretation	
	Instructors	Students	Instructors	Students	Instructors	Students	Instructors	Students	Instructors	Students
1. Easy to assemble and disassemble.	3.00 A	3.02 A	3.09 A	3.18 A	4.00 SA	3.57 SA	3.52	3.26	A	A
2. Intuitive interface or control panel.	3.00 A	2.90 A	3.00 A	3.36 SA	2.67 A	3.57 SA	3.61	3.28	SA	SA
3. Clearly labeled components and functions.	2.25 D	2.91 A	3.09 A	3.26 A	4.00 SA	3.54 SA	3.51	3.24	SA	A
4. Minimal supervision needed during use.	3.25 A	2.81 A	2.45 D	3.31 SA	2.67 A	3.71 SA	3.07	3.28	A	SA
5. Requires minimal time to learn or master.	3.75 SA	2.93 A	2.73 A	3.42 SA	2.67 A	3.66 SA	3.54	3.34	SA	SA
6. Accompanied by user-friendly manuals or guides.	3.25 A	3.03 A	3.09 A	3.45 SA	4.00 SA	3.61 SA	3.61	3.36	SA	SA
7. Students can independently operate after basic orientation.	2.50 D	2.82 A	2.18 D	3.37 SA	3.33 SA	3.62 SA	3.65	3.27	SA	A
8. Compatible with existing classroom/lab systems.	3.00 A	2.86 A	2.17 D	3.36 SA	3.00 A	3.64 SA	3.46	3.29	SA	SA
9. Easily transportable or movable within lab spaces.	2.50 D	2.84 A	2.45 D	3.37 SA	3.00 A	3.54 SA	3.43	3.25	SA	A
10. Readily available spare parts or troubleshooting support.	2.00 D	2.96 A	2.90 A	3.44 SA	2.67 A	3.65 SA	2.52	3.35	A	SA
Average	2.75 A	2.91 A	2.72 A	3.35 SA	3.20 A	3.61 SA	2.89	3.29	A	SA

Legend: 3.28-4.00 (Strongly Agree) 2.52-3.27 (Agree) 1.76-2.51 (Disagree) 1.00-1.75 (Strongly disagree)

The results for Amando Cope College indicate moderate ease of operation, with instructors generally rating the indicators higher than students. Most instructor responses fall under "Agree," with a notable "Strongly Agree" in the indicator on requiring minimal time to learn or master (3.75). However, several critical indicators received lower ratings, particularly

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clearly labeled components (2.25), independent student operation (2.50), portability (2.50), and availability of spare parts (2.00), all interpreted as "Disagree." Student ratings, while slightly more consistent in the "Agree" range, still reflect limitations in areas such as supervision requirements (2.81), independent operation (2.82), and compatibility (2.86).

Bicol College demonstrates high ease of operation, with both instructors and students consistently providing favorable ratings. Most instructor responses fall within "Agree," although a few indicators such as minimal supervision (2.45), independent operation (2.18), compatibility (2.17), and portability (2.45) are rated lower, indicating some operational constraints. In contrast, student ratings are predominantly "Strongly Agree," particularly in intuitive interface (3.36), minimal supervision (3.31), learning time (3.42), and independent operation (3.37), suggesting that students find the equipment accessible and easy to use. The availability of user-friendly manuals (3.45) and spare parts (3.44) further supports operational efficiency.

PLT College of Guinobatan, Inc. reflects generally positive but slightly varied results in terms of ease of operation. Instructors rated most indicators within the "Agree" to "Strongly Agree" range, with high ratings in ease of assembly (4.00), labeling (4.00), and availability of manuals (4.00), indicating that they perceive the equipment as straightforward and well-supported. However, some indicators such as intuitive interface (2.67), supervision requirements (2.67), and learning time (2.67) received relatively lower ratings, suggesting moderate difficulty in actual operation. Student responses, on the other hand, are consistently high, mostly interpreted as "Strongly Agree," particularly in supervision (3.71), learning time

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(3.66), independent operation (3.62), compatibility (3.64), and troubleshooting support (3.65).

The findings reveal that ease of operation significantly influences students' ability to independently and efficiently utilize forensic laboratory equipment. Institutions such as Bicol College and PLT College, where higher ease-of-use ratings were observed, are more likely to promote active, hands-on learning and facilitate skill acquisition with minimal instructional barriers. In contrast, the lower ratings in Amando Cope College, particularly in labeling, independent operation, and availability of support resources, suggest potential obstacles that may limit student autonomy and slow the learning process.

This implicates that ease of operation directly influences students' ability to independently and efficiently utilize forensic laboratory equipment, where higher usability supports more active and self-directed learning, while operational constraints may hinder full engagement and slow the development of practical competencies in forensic laboratory practice. These results underscore the importance of investing in user-friendly equipment, clear instructional materials, and accessible maintenance support to enhance operational efficiency. Strengthening these aspects can improve laboratory learning experiences and ultimately enhance the practical competencies of criminology students.

This finding is supported by Amankwaa (2023), who noted that user-friendly equipment reduces cognitive load and enhances the application of theoretical knowledge, as reflected in higher ease-of-use ratings in institutions such as Bicol College and PLT College.

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Conversely, lower usability ratings, particularly in aspects such as labeling, independent operation, and support resources, are consistent with the findings of Moyaki et al. (2026) and Ramli et al. (2025), who emphasized that unclear procedures and poorly designed instructional materials reduce usability and learning efficiency. Furthermore, Batangas State University (2024) highlighted that structured training enhances familiarity with laboratory tools, while Escobar-Castillejos et al. (2024) underscored that intuitive systems improve task completion and overall learning effectiveness.

c. Safety

This section presents the safety aspect of laboratory equipment used in forensic science subjects, focusing on how well safety protocols, protective measures, and equipment handling practices are observed to ensure the well-being of students during laboratory activities. It evaluates students' awareness and adherence to safety procedures, as well as the availability of safety resources such as manuals, signage, and emergency equipment. Through this analysis, it highlights potential risks, gaps, and areas for improvement in promoting a culture of safety within forensic laboratory settings.

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Table 2.c

Safety

Indicators	Amando Cope College				Bicol College				PLTCGI				Average Weighted Mean		Adjectival Interpretation	
	Instructors		Students		Instructors		Students		Instructors		Students		Instructors	Students	Instructors	Students
	WM	AI	WM	AI	WM	AI	WM	AI	WM	AI	WM	AI				
1. Equipped with proper insulation and protective covering.	3.75	SA	3.01	A	2.82	A	3.36	SA	3.00	A	3.61	SA	3.19	3.33	A	SA
2. Includes safety instructions and warning labels.	4.00	SA	3.07	A	2.36	D	3.31	SA	3.00	A	3.64	SA	3.12	3.34	A	SA
3. No history of equipment-related injuries or accidents.	4.00	SA	2.99	A	3.09	A	3.36	SA	4.00	SA	3.62	SA	3.70	3.32	SA	SA
4. Comes with standard safety gear (e.g., gloves, goggles).	3.75	SA	2.96	A	2.72	A	3.33	SA	2.00	D	3.64	SA	2.82	3.31	A	SA
5. Designed to minimize exposure to harmful substances.	4.00	SA	3.04	A	3.09	A	3.30	SA	2.67	D	3.54	SA	3.25	3.29	A	SA
6. Proper grounding and electrical safety compliance.	4.00	SA	2.95	A	2.72	A	3.37	SA	4.00	SA	3.61	SA	3.57	3.31	SA	SA
7. Clear emergency shut-off features.	4.00	SA	2.99	A	2.45	D	3.31	SA	3.67	SA	3.58	SA	3.37	3.29	SA	SA
8. Safe to use in both individual and group lab settings.	4.00	SA	2.90	A	3.09	A	3.29	SA	3.67	SA	3.57	SA	3.59	3.25	SA	A
9. Well-maintained and regularly inspected.	3.75	SA	2.99	A	2.82	A	3.35	SA	3.33	SA	3.61	SA	3.30	3.32	SA	SA
10. Encourages adherence to safety protocols among students.	4.00	SA	2.98	A	3.09	A	3.31	SA	4.00	SA	3.56	SA	3.70	3.28	SA	SA
Average	3.92	SA	2.99	A	2.82	A	3.32	SA	3.33	SA	3.60	SA	3.36	3.30	SA	SA

Legend: 3.28-4.00 (Strongly Agree) 2.52-3.27 (Agree) 1.76-2.51 (Disagree) 1.00-1.75 (Strongly disagree)

The results for Amando Cope College reveal that instructors consistently rated all safety indicators as "Strongly Agree," with high scores across all aspects such as insulation (3.75), safety instructions (4.00), absence of accidents (4.00), provision of safety gear (3.75), and adherence to safety protocols (4.00). This indicates a strong perception among instructors that laboratory equipment meets safety standards and is reliable for instructional use. In contrast, student ratings are notably lower, mostly within the "Agree" range, particularly in areas such as maintenance (2.99), emergency features (2.99), and provision of safety gear (2.96).

Bicol College demonstrates generally positive safety ratings, though with some variability in instructor responses. Instructors rated most indicators as "Agree," with a notable

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“Disagree” in the presence of safety instructions and warning labels (2.36) and emergency shut-off features (2.45), indicating specific areas of concern. However, student ratings are consistently high, with all indicators interpreted as “Strongly Agree,” including insulation (3.36), accident-free operation (3.36), availability of safety gear (3.33), and adherence to safety protocols (3.31). Students also rated electrical safety (3.37) and maintenance (3.35) positively, suggesting a strong perception of a safe laboratory environment.

PLT College of Guinobatan, Inc. shows mixed but generally favorable safety results. Instructors rated several indicators as “Strongly Agree,” such as absence of accidents (4.00), electrical safety (4.00), emergency features (3.67), and adherence to safety protocols (4.00), reflecting confidence in key safety aspects. However, lower ratings are observed in the provision of safety gear (2.00) and minimizing exposure to harmful substances (2.67), indicating specific deficiencies. Student ratings, on the other hand, are consistently high, with all indicators interpreted as “Strongly Agree,” including insulation (3.61), safety instructions (3.64), accident-free operation (3.62), and maintenance (3.61).

The findings reveal that while laboratory equipment across the three institutions is generally perceived as safe, discrepancies between instructor and student responses emphasize gaps in consistency, visibility, and adequacy of safety measures. High safety ratings, particularly in Bicol College and PLT College, support the creation of a secure learning environment that promotes confidence and active participation in laboratory activities. However, specific issues such as insufficient safety gear, lack of clear warning labels, and

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limited emergency features in some institutions may expose students to potential risks and hinder full compliance with safety standards.

These findings suggest that while safety standards may be generally present, inconsistencies in implementation and perception across institutions may affect the uniformity of safety experiences in laboratory settings. Such variations highlight the importance of ensuring not only the presence of safety measures but also their consistent visibility, accessibility, and enforcement to support a truly safe and reliable forensic laboratory environment. These results emphasize the need for continuous safety audits, provision of complete protective equipment, clear labeling, and reinforcement of safety protocols to ensure that all users both instructors and students experience a uniformly safe and controlled laboratory environment.

To support this implication, Wu (2023) notes that insufficient or inconsistent safety instruction leads to weak understanding of safety signs and procedures, while Aliyo and Edin (2023) identify gaps in safety manuals, inspections, and training that expose students to risks. Zhao (2023) further explains that unsafe outcomes often result from improper equipment use and procedural lapses, reinforcing the need for strict safety protocols. In addition, Abdullah and Aziz (2020) emphasize that safety knowledge must be reinforced by consistent behavior, aligning with variations observed in safety practices among respondents. Mendez (2024) and Pekdağ (2020) both demonstrate that structured environments and targeted safety instruction significantly improve safety performance and awareness. Overall, the literature highlights that

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laboratory safety is multidimensional and depends on consistent institutional implementation and instruction to maintain a safe learning environment.

3. Impact of Utilization on student's competence

This section presents the impact of laboratory equipment utilization on students' competence in terms of practical skills acquisition, critical thinking, and application of forensic techniques, based on the responses of criminology students and instructors from Amando Cope College, Bicol College, and PLT College of Guinobatan, Inc. It examines how the use of forensic laboratory equipment contributes to the development of essential competencies required in the effective practice and application of forensic science. In particular, it explores how hands-on exposure to laboratory tools and procedures enhances students' ability to perform forensic tasks accurately, analyze evidence systematically, and apply scientific principles in real or simulated investigative contexts. Furthermore, it provides insights into how instructional practices and laboratory experiences collectively shape the readiness and proficiency of students in performing discipline-specific competencies essential in criminology education.

a. Practical Skills Acquisition

This subsection presents the impact of laboratory equipment utilization on students' practical skills acquisition. It focuses on how hands-on engagement with forensic laboratory tools and procedures enhances the development of essential technical competencies, including proper handling of equipment, accurate execution of laboratory techniques, and adherence to standard forensic protocols among criminology students.

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Table 3.a

Practical Skills Acquisition

Indicators	Amando Cope College				Bicol College				PLTCGI				Average Weighted Mean		Adjectival Interpretation	
	Instructors		Students		Instructors		Students		Instructors		Students		Instructors	Students	Instructors	Students
	WM	AI	WM	AI	WM	AI	WM	AI	WM	AI	WM	AI				
1. Increases student ability to operate forensic laboratory equipment confidently.	4.00	SA	3.19	A	2.37	D	3.34	SA	3.33	SA	3.92	SA	3.23	3.48	A	SA
2. Enhanced proficiency in performing hands-on forensic tasks (e.g., fingerprinting, chemical analysis).	4.00	SA	3.07	A	2.73	A	3.37	SA	4.00	SA	3.68	SA	3.58	3.37	SA	SA
3. Improves execution of lab-based experiments through repeated equipment use.	4.00	SA	3.16	A	2.90	A	3.30	SA	4.00	SA	3.66	SA	3.63	3.37	SA	SA
4. Faster task completion due to familiarity with equipment.	4.00	SA	2.93	A	2.45	D	3.28	SA	3.67	SA	3.66	SA	3.27	3.29	A	SA
5. Higher accuracy in handling and analyzing forensic evidence.	4.00	SA	3.02	A	2.27	D	3.39	SA	3.33	SA	3.57	SA	3.20	3.33	A	SA
6. Greater independence in conducting laboratory procedures.	4.00	SA	3.07	A	2.18	D	3.28	SA	3.33	SA	3.66	SA	3.17	3.34	A	SA
7. Reduction in procedural errors due to experience with equipment.	3.25	A	2.99	A	2.37	D	3.37	SA	3.67	SA	3.65	SA	3.10	3.34	A	SA
8. Demonstrate readiness for field or practicum work based on lab practice.	3.00	A	3.11	A	2.37	D	3.33	SA	4.00	SA	3.58	SA	3.12	3.34	A	SA
9. Effective transfer of lab training to mock crime scene simulations.	3.25	A	2.99	A	2.46	D	3.36	SA	3.00	A	3.58	SA	2.90	3.31	A	SA
10. Students report gaining valuable skills through exposure to real forensic tools.	4.00	SA	3.00	A	2.37	D	3.40	SA	4.00	SA	3.70	SA	3.46	3.37	SA	SA
Average	3.75	SA	3.05	A	2.45	D	3.34	SA	3.63	SA	3.67	SA	3.28	3.35	SA	SA

Legend: 3.28-4.00 (Strongly Agree) 2.52-3.27 (Agree) 1.76-2.51 (Disagree) 1.00-1.75 (Strongly disagree)

The findings for Amando Cope College show that instructors consistently rated all indicators very high, with most interpreted as “Strongly Agree,” particularly in enhancing confidence (4.00), proficiency in tasks (4.00), execution of experiments (4.00), accuracy (4.00), independence (4.00), and perceived value of skills (4.00). This reflects a strong belief among instructors that laboratory equipment significantly contributes to students’ practical skill development. However, student ratings are comparatively lower, generally within the “Agree” range, with scores such as confidence (3.19), proficiency (3.07), and independence (3.07). Indicators like faster task completion (2.93) and reduction of errors (2.99) further reflect moderate impact.

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Bicol College presents a contrasting pattern, where instructor ratings are relatively low, with several indicators interpreted as "Disagree," including confidence (2.37), task efficiency (2.45), accuracy (2.27), independence (2.18), and transfer of learning (2.46). In contrast, student ratings are consistently high, with all indicators interpreted as "Strongly Agree," including confidence (3.34), proficiency (3.37), execution (3.30), independence (3.28), and readiness for practicum (3.33). Students also report strong agreement in gaining valuable skills (3.40).

PLT College of Guinobatan, Inc. demonstrates consistently high ratings from both instructors and students, with most indicators interpreted as "Strongly Agree." Instructors rated key indicators such as proficiency (4.00), execution (4.00), readiness for practicum (4.00), and perceived value (4.00) very highly, indicating strong confidence in the role of equipment in developing practical skills. Student responses align closely, with high ratings in confidence (3.92), proficiency (3.68), execution (3.66), independence (3.66), and transfer of learning (3.58). Indicators such as faster task completion (3.66) and reduction of errors (3.65) further support the effectiveness of equipment utilization.

The findings reveal that the utilization of laboratory equipment has a substantial impact on the development of students' practical forensic skills; however, the extent of this impact varies across institutions and between instructors and students. High and consistent ratings, as seen in PLT College, indicate that effective utilization leads to improved confidence, accuracy, independence, and readiness for real-world forensic tasks. In contrast, discrepancies such as those observed in Amando Cope College and Bicol College suggest gaps

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between perceived and actual skill acquisition, potentially due to limited hands-on exposure, insufficient practice time, or differences in performance expectations.

These variations imply that inconsistencies between perceived and actual learning outcomes may be influenced by differences in laboratory engagement, practice opportunities, and instructional expectations, which collectively affect the degree to which forensic competencies are developed through equipment utilization. These results highlight the need for strengthening laboratory-based instruction through increased access to equipment, structured skill-based activities, and performance-based assessments to ensure that perceived competence aligns with actual technical proficiency among criminology students.

This is supported by Chu (2024), who emphasizes that structured laboratory engagement improves technical proficiency, while Waheed (2024) highlights that repeated hands-on exposure enhances precision and problem-solving skills. Similarly, Bracewell and Jones (2022) stress that simulation and real-case laboratory activities strengthen forensic application, and Sebulan (2024) confirms that direct interaction with forensic instruments significantly improves procedural mastery.

b. Critical thinking

This subsection presents the impact of laboratory equipment utilization on students' critical thinking. It examines how exposure to forensic laboratory activities supports the development of analytical reasoning, problem-solving abilities, and evidence-based decision-

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making among criminology students as they interpret findings and evaluate forensic procedures.

Table 3.b

Critical Thinking

Indicators	Amando Cope College				Bicol College				PLTCGI				Average Weighted Mean		Adjectival Interpretation	
	Instructors		Students		Instructors		Students		Instructors		Students		Instructors	Students	Instructors	Students
	WM	AI	WM	AI	WM	AI	WM	AI	WM	AI						
1. Equipment use encourages students to interpret forensic data critically.	3.75	SA	3.13	A	2.63	A	3.32	SA	3.67	SA	3.65	SA	3.35	3.37	SA	SA
2. Exposure to lab scenarios sharpens problem-solving abilities.	4.00	SA	3.02	A	2.18	D	3.35	SA	4.00	SA	3.64	SA	3.39	3.34	SA	SA
3. Students formulate hypotheses and test them using lab equipment.	4.00	SA	3.17	A	2.63	A	3.36	SA	3.67	SA	3.53	SA	3.43	3.35	SA	SA
4. Enhances analytical decision-making through equipment-generated data.	3.25	A	3.05	A	2.81	A	3.37	SA	4.00	SA	3.58	SA	3.35	3.33	SA	SA
5. Encourages deeper understanding of forensic results and limitations.	3.00	A	3.03	A	2.91	A	3.30	SA	4.00	SA	3.64	SA	3.30	3.32	SA	SA
6. Promotes comparison of outcomes from different forensic tools.	4.00	SA	3.04	A	2.37	D	3.30	SA	3.67	SA	3.65	SA	3.35	3.33	SA	SA
7. Develops the ability to justify conclusions based on equipment findings.	4.00	SA	3.02	A	2.72	A	3.34	SA	4.00	SA	3.67	SA	3.57	3.34	SA	SA
8. Students critically evaluate the effectiveness of tools used.	3.25	A	2.96	A	2.45	D	33.3 2	SA	3.63	SA	3.54	SA	3.11	3.27	A	A
9. Strengthens investigative reasoning using real forensic setups.	4.00	SA	3.91	A	2.37	D	3.36	SA	3.67	SA	3.72	SA	3.35	3.33	SA	SA
10. Facilitates exploration of alternative methods when equipment output varies.	3.75	SA	2.95	A	2.63	A	3.42	SA	4.00	SA	3.63	SA	3.46	3.33	SA	SA
Average	3.70	SA	3.03	A	2.57	A	3.34	SA	3.83	SA	3.64	SA	3.37	3.33	SA	SA

Legend: 3.28-4.00 (Strongly Agree) 2.52-3.27 (Agree) 1.76-2.51 (Disagree) 1.00-1.75 (Strongly disagree)

The findings for Amando Cope College indicate that instructors perceive a strong impact of laboratory equipment on students' critical thinking, with most indicators rated as "Strongly Agree," particularly in problem-solving (4.00), hypothesis testing (4.00), comparison of tools (4.00), justification of conclusions (4.00), and investigative reasoning (4.00). However, some indicators such as analytical decision-making (3.25), evaluation of tools (3.25), and understanding limitations (3.00) fall under "Agree," suggesting slight moderation in these areas. Student responses, on the other hand, are consistently within the "Agree"

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range, including interpretation (3.13), hypothesis testing (3.17), and reasoning (3.91), indicating that while students recognize the contribution of equipment to their thinking skills, the impact is not as strongly perceived as by instructors.

Bicol College presents a contrasting pattern, where instructor ratings are relatively low across several indicators, with some interpreted as "Disagree," particularly in problem-solving (2.18), comparison of tools (2.37), evaluation of tools (2.45), and investigative reasoning (2.37). Even in indicators rated as "Agree," such as interpretation (2.63) and hypothesis testing (2.63), the scores remain modest. This suggests that instructors perceive limited impact of equipment utilization on developing higher-order thinking skills. In contrast, student ratings are consistently high, with all indicators interpreted as "Strongly Agree," including interpretation (3.32), problem-solving (3.35), hypothesis testing (3.36), and exploration of alternatives (3.42). Students also report strong development in reasoning (3.36) and evaluation (3.32).

PLT College of Guinobatan, Inc. demonstrates consistently high ratings from both instructors and students, with most indicators interpreted as "Strongly Agree." Instructors rated several indicators very highly, including problem-solving (4.00), analytical decision-making (4.00), understanding limitations (4.00), and justification of conclusions (4.00), reflecting strong confidence in the effectiveness of laboratory equipment in fostering critical thinking. Student responses align closely, with high ratings in interpretation (3.65), reasoning (3.72), hypothesis testing (3.53), and comparison of tools (3.65). Indicators such as

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evaluation of tools (3.54) and exploration of alternatives (3.63) further support the development of advanced thinking skills.

The findings reveal that laboratory equipment utilization plays a crucial role in enhancing students' critical thinking skills, particularly in interpreting forensic data, solving problems, and making evidence-based decisions. Institutions like PLT College, where both instructors and students report high impact, demonstrate that effective and consistent use of laboratory resources can significantly strengthen higher-order cognitive skills essential in forensic practice. However, discrepancies observed in Amando Cope College and especially in Bicol College indicate gaps between perceived and actual development of critical thinking, possibly due to differences in instructional strategies, assessment standards, or depth of engagement with laboratory activities.

These variations indicate that the effectiveness of laboratory equipment in fostering critical thinking is influenced not only by resource availability but also by instructional strategies, student engagement, and the extent to which laboratory activities are structured to promote analytical reasoning and evidence-based problem solving. These results highlight the need for structured inquiry-based learning, integration of analytical tasks, and performance-based evaluations to ensure that laboratory experiences genuinely cultivate critical thinking competencies among criminology students.

This is supported by Carmo (2025), who emphasizes that problem-based forensic laboratory activities enhance independent analysis and critical reasoning, while Magwilang

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(2022) highlights that case-based instruction strengthens problem-solving and higher-order thinking through evidence evaluation. Similarly, Bracewell and Jones (2022) note that simulated crime scene activities improve analytical reasoning and decision-making, while Delémont (2022) adds that combining digital simulations with hands-on work further enhances hypothesis formation and forensic data interpretation. In addition, Mundy and Nokeri (2024) confirm that inquiry-oriented laboratory instruction significantly improves analytical and problem-solving skills, reinforcing the importance of evidence-based and experiential learning in developing forensic critical thinking.

c. Application of Forensic Techniques

This subsection presents the impact of laboratory equipment utilization on students' application of forensic techniques. It focuses on how hands-on laboratory experiences enable criminology students to appropriately apply theoretical knowledge in actual forensic procedures, ensuring correct execution of techniques such as evidence collection, analysis, and interpretation in line with established forensic standards. It further examines how consistent exposure to laboratory-based activities strengthens procedural accuracy, technical confidence, and adherence to standardized forensic protocols, all of which are essential in developing professional competence in forensic practice.

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Table 3.c

Application of Forensic Techniques

Indicators	Amando Cope College				Bicol College				PLTCGI				Average Weighted Mean		Adjectival Interpretation	
	Instructors		Students		Instructors		Students		Instructors		Students		Instructors	Students	Instructors	Students
	WM	AI	WM	AI	WM	AI	WM	AI	WM	AI	WM	AI				
1. Equipment use enables students to simulate actual forensic procedures.	4.00	SA	3.03	A	2.82	A	3.37	SA	4.00	SA	3.56	SA	3.61	3.32	SA	SA
2. Improved application of proper techniques due to hands-on training.	3.25	A	3.07	A	2.54	A	3.38	SA	4.00	SA	3.65	SA	3.26	3.37	A	SA
3. Students accurately replicate real-world forensic protocols using equipment.	3.75	SA	2.99	A	2.5	A	3.27	SA	4.00	SA	3.63	SA	3.43	3.30	SA	SA
4. Greater alignment of student practice with forensic field standards.	3.00	A	2.28	A	2.82	A	3.35	SA	3.67	SA	3.58	SA	3.16	3.07	SA	A
5. Enhanced integration of theory and practice in lab-based tasks.	3.75	SA	2.94	A	2.81	A	3.38	SA	4.00	SA	3.59	SA	3.52	3.30	SA	SA
6. Enables step-by-step application of multi-stage forensic procedures.	4.00	SA	3.03	A	2.55	A	3.39	SA	3.33	SA	3.59	SA	3.29	3.34	A	SA
7. Reinforces proper evidence collection and preservation using tools.	4.00	SA	3.02	A	2.54	A	3.40	SA	3.00	SA	3.56	SA	3.18	3.33	SA	SA
8. Promotes use of the right technique depending on case scenario.	3.75	SA	3.02	A	2.63	A	3.34	SA	3.67	SA	3.65	SA	3.35	3.34	A	SA
9. Students demonstrate advanced technique application in laboratory assessments.	3.00	A	2.96	A	2.37	A	3.32	SA	3.33	SA	3.71	SA	2.90	3.33	SA	SA
10. Use of laboratory equipment boosts student confidence in applying forensic method	4.00	SA	3.59	SA	3.00	D	3.38	SA	4.00	SA	3.62	SA	3.67	3.53	SA	SA
Average	3.65	SA	2.69	A	2.66	A	3.36	SA	3.70	SA	3.61	SA	3.34	3.22	SA	A

The findings for Amando Cope College show that instructors perceive a strong impact of laboratory equipment on students' ability to apply forensic techniques, with most indicators rated as "Strongly Agree," including simulation of procedures (4.00), replication of protocols (3.75), integration of theory and practice (3.75), and confidence in applying methods (4.00). Indicators such as alignment with field standards (3.00) and advanced application (3.00) are rated "Agree," indicating moderate effectiveness in higher-level application. In contrast, student responses are consistently within the "Agree" range, with relatively lower ratings in alignment with field standards (2.28), advanced application (2.96), and integration of theory and practice (2.94). Only confidence in applying methods reached "Strongly Agree" (3.59).

Bicol College presents moderate instructor ratings, mostly within the "Agree" range across indicators such as simulation (2.82), technique application (2.54), replication (2.50),

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and integration of theory and practice (2.81). Notably, confidence in applying forensic methods is rated lower (3.00, interpreted as “Disagree”), indicating concern regarding students’ readiness to apply techniques independently. In contrast, student ratings are consistently high, with all indicators interpreted as “Strongly Agree,” including simulation (3.37), technique application (3.38), replication (3.27), alignment with standards (3.35), and advanced application (3.32). Students also report strong confidence (3.38) and effective use of multi-stage procedures (3.39).

PLT College of Guinobatan, Inc. demonstrates consistently high ratings from both instructors and students, with most indicators interpreted as “Strongly Agree.” Instructors rated key indicators such as simulation of procedures (4.00), proper technique application (4.00), replication of protocols (4.00), integration of theory and practice (4.00), and confidence (4.00) at the highest level, indicating strong confidence in students’ applied competencies. Student responses closely align, with high ratings in simulation (3.56), application (3.65), replication (3.63), evidence handling (3.56), and advanced application (3.71). Indicators such as alignment with standards (3.58) and technique selection (3.65) further reinforce strong applied skills.

The findings reveal that laboratory equipment utilization significantly enhances students’ ability to apply forensic techniques; however, the level of impact varies across institutions and between instructors and students. Strong alignment in PLT College indicates that consistent, hands-on exposure to functional equipment leads to effective translation of theory into practice and readiness for real-world forensic work. Conversely, discrepancies

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observed in Amando Cope College and Bicol College suggest that while students feel confident in their abilities, instructors may perceive deficiencies in technical accuracy, advanced application, and adherence to professional standards.

These variations imply that effective application of forensic techniques depends not only on the availability of laboratory equipment but also on the quality of instructional delivery, consistency of practice opportunities, and alignment between instructional expectations and student performance outcomes. These gaps highlight the need for more structured, competency-based laboratory training, increased exposure to realistic forensic scenarios, and rigorous performance evaluation to ensure that students not only gain confidence but also achieve mastery in applying forensic techniques.

This is supported by Noli (2005), who emphasizes that institutional support and quality laboratory equipment are critical determinants of forensic competency development, while Seban (2024) highlights that hands-on forensic ballistics activities strengthen analytical and technical proficiency. Similarly, Espartero (2022 as cited by Basalo, 2025) notes that simulated real-world laboratory exercises enhance the integration of theory and practice, and Li et al. (2025) emphasize that scenario-based simulation instruction improves forensic competencies through applied learning. In addition, Sutay et al. (2024) confirm that structured laboratory-based training supports both theoretical understanding and practical skill development, reinforcing the importance of hands-on and simulation-driven instruction in forensic education.

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4. Challenges in the utilization of laboratory equipment in teaching forensic science subjects.

This section presents the challenges faced by instructors in using laboratory equipment in teaching forensic science. Respondents are identified as BC 1–6 (Bicol College), PLT 1–2 (PLT College of Guinobatan, Inc.), and AC 1 (Amando Cope College).

a. Limited facilities

This theme shows how insufficient laboratory facilities hinder the proper conduct of activities, often leading to overcrowding and limiting students' opportunities to fully participate in hands-on learning.

According to BC2: "May mga activity na ipagagawa sana, kaso kulang sa facilities." (Intended activities could not be carried out due to insufficient laboratory facilities.)

BC3 added: "Di accommodated ang ibang students since kulang ang facility. Minsan sabay sabay pa gagamit ng laboratory." (Limited facilities lead to overcrowding and distractions when multiple students use the laboratory at the same time.)

The responses indicate that limited laboratory facilities significantly hinder the effective delivery of forensic science laboratory activities. Both BC2 and BC3 highlight that insufficient space and facilities restrict the conduct of intended hands-on exercises and lead to overcrowding when multiple students are scheduled to use the laboratory simultaneously. This

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condition reduces students' access to direct laboratory engagement, disrupts the flow of activities, and compromises the quality of experiential learning. The recurring concern across respondents suggests that facility inadequacy is not an isolated issue but a systemic limitation affecting instructional delivery and student participation in forensic science practical work.

The presence of limited laboratory facilities implies that students' opportunities for hands-on forensic training are constrained, which may negatively affect the development of their practical competencies and procedural familiarity. Overcrowding and restricted access to laboratory spaces reduce the efficiency and effectiveness of experiential learning, thereby limiting students' exposure to essential forensic techniques. This highlights the need for institutions to improve laboratory infrastructure, expand available facilities, and implement proper scheduling or class segmentation to ensure equitable access. Strengthening laboratory capacity is essential to support consistent skill development and to maintain the quality of forensic science instruction.

This is strongly supported by Hiyan et al. (2025), who highlight that outdated equipment and insufficient laboratory resources significantly limit effective hands-on learning and instructional delivery. Similarly, Masudi (2023) emphasizes that infrastructure deficiencies and resource limitations directly hinder forensic laboratory practice and reduce students' experiential learning opportunities. In addition, Mohzana et al. (2023) stress that poor laboratory management and lack of organized practicum implementation restrict student engagement in laboratory activities, reinforcing the need for improved operational systems alongside infrastructure development.

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b. Unconducive Laboratory facility

This theme reflects how poor laboratory conditions, such as inadequate ventilation, lighting, and shared space, create an environment that is not suitable for effective learning and affects students' focus and performance.

According to BC2 "Mainit ang facilities. Hindi maka focus ang students sa paggamit ng equipment ta burulos na ang daplos. It's not conducive for laboratory use" (Poor ventilation makes it difficult for students to focus during activities. Its not conducive for laboratory use)Also according to BC2:

"May mga activities na gagamit ng equipment... hindi angkop yung facility... kailangan ilipat." (Facilities are not suitable, causing delays due to transfer).

It is also added by BC2 that "Problem is yung hindi naman forensic subject, yun ang gagamit ng laboratory room." (Non-forensic subjects also use the laboratory.)

AC1 stated that, "Yung Poor lighting conditions naapektuhan nya yung the clarity ng photos". (Poor lighting conditions also affected the clarity of the photos).

The responses of the participants consistently indicate that limited laboratory facilities pose a significant challenge in the utilization of laboratory equipment in teaching forensic science. As expressed by BC2, the insufficiency of facilities prevents the implementation of

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intended laboratory activities, suggesting a misalignment between instructional goals and available resources. Similarly, BC3 highlighted that the lack of adequate space results in overcrowding, where multiple students are forced to use the laboratory simultaneously. This condition not only limits student access to equipment but also reduces the quality of hands-on learning, as students may have fewer opportunities to actively engage in practical tasks.

The findings imply that institutions must prioritize the enhancement and expansion of laboratory facilities to support effective forensic science instruction. Adequate facilities are essential to ensure that all planned laboratory activities are conducted and that students receive sufficient hands-on experience. Additionally, schools may consider implementing improved scheduling strategies, such as staggered laboratory sessions or smaller group allocations, to address overcrowding and maximize the use of existing resources. In the long term, institutional investment in laboratory infrastructure is necessary to meet the increasing demands of student population and to maintain the quality of practical education, ultimately ensuring that learners are well-equipped with the skills required in forensic science practice.

Masudi (2023) noted that forensic laboratories often face inadequate infrastructure and limited resources, which hinder the implementation of practical activities and reduce student engagement. Similarly, Santos (2024) reported that restrictions in laboratory space and facilities prevent optimal utilization of forensic resources, limiting opportunities for hands-on experience.

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c. Lack of Laboratory Equipment

This theme emphasizes the challenges caused by inadequate, outdated, or non-functional laboratory equipment, which restricts the implementation of activities and prevents equal access for all students.

According to AC1: "Isang challenge yung lack of laboratory equipment" (One challenge encountered is lack of laboratory equipment)

BC2 stated, "Lack of equipment... may mga gusto kang ipagawa... kaso walang equipment." (Activities cannot be conducted due to lack of equipment.)

This statement is supported by BC6 who stated that: "Kulang sa equipment and tools. Hindi sapat para sa lahat ng students." (Equipment is not enough for all students.)

BC3 added that: "Limited equipment, di nakakagamit lahat ng students..." (Not all students can use equipment.)

Also according to BC3: "Lack of reagents... expired... outdated equipment... not functioning." (Reagents are lacking or expired; equipment is outdated or not working.)

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BC4 stated that: "Isa lang yung manual and digital camera... chemicals outdated... wala din kaming firearms." (Very limited equipment; some are outdated or unavailable.)

According to BC5 "Yung equipment naming luma na... for familiarization na lang." (Equipment is outdated and only used for familiarization.)

Lastly, BC5 stated that: "May kulang na parts or cord... di magamit." (Equipment cannot be used due to missing parts.)

The responses of the participants clearly show that the lack of laboratory equipment is a major challenge in teaching forensic science. Many of them pointed out that there are not enough tools and materials for all students, which makes it hard to carry out planned laboratory activities. Because of this, some students are not able to participate fully, and hands-on learning becomes limited. This is a problem since forensic science relies heavily on actual practice to develop skills. In addition, several participants mentioned that some of the available equipment is already old, expired, broken, or missing parts. Instead of being used for real activities, some are only used for demonstration or familiarization.

The findings suggest that schools need to give more attention to providing and maintaining laboratory equipment. Institutions should invest in enough and updated tools so that all students can actively participate in laboratory activities. It is also important to regularly check, repair, and replace damaged or outdated equipment to make sure everything is safe and usable. Proper management of materials, such as chemicals and other supplies, should

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also be observed. By improving these areas, schools can provide better learning experiences and help students develop the practical skills they need for real forensic work.

The importance of providing and maintaining adequate laboratory equipment is well-supported in the literature. Hiyan et al. (2025) and Upendra (2025) emphasized that challenges such as outdated, insufficient, or poorly maintained equipment significantly hinder practical learning in science education. Masudi (2023) similarly highlighted that limited resources in forensic laboratories prevent students from fully engaging in hands-on activities, while Santos (2024) noted that constraints in equipment and materials reduce the effectiveness of laboratory instruction.

d. Operational Delays

This theme reveals how time-consuming processes, equipment transfers, and scheduling conflicts contribute to delays, reducing the efficiency and actual time spent on laboratory activities.

PLT1 "Pag transfer ng mga gamit... naka cabinet... it takes time... nagkakaran ng delay." (Retrieving equipment causes delays).

BC2 supported that: "Kailangan mo pa ilipat... it takes time... nagkakaran ng delay." (Equipment transfer causes delays).

BC2 "May mga process pang dakulon before mag activity... not convenient..." (Too many processes before conducting activities is not convenient)

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BC2 *"Conflict ng schedule... lack of time na. so di na makapag laboratory."*

(Scheduling conflicts reduce time for lab use.)

The responses of the participants show that operational delays are another challenge in the use of laboratory equipment in teaching forensic science. Several respondents (PLT1 and BC2) pointed out that retrieving and transferring equipment takes too much time, especially when materials are stored in cabinets or located far from the laboratory area. This extra time reduces the actual time available for conducting laboratory activities. In addition, BC2 mentioned that there are too many processes that need to be completed before starting an activity, making it inconvenient and time-consuming. Scheduling conflicts were also identified as a concern, where limited time and overlapping schedules sometimes prevent laboratory sessions from happening at all.

The findings imply that institutions need to improve the organization and management of laboratory operations to reduce delays. Schools may consider arranging equipment in a more accessible way or placing commonly used materials within the laboratory to save time. Simplifying procedures before laboratory activities and reducing unnecessary steps can also help make the process more efficient. In addition, better scheduling and coordination of laboratory use are needed to avoid conflicts and ensure that sufficient time is given for hands-on activities. By addressing these concerns, institutions can make laboratory sessions more efficient and allow students to fully benefit from their practical experiences. Time constraints, misaligned schedules, and procedural inefficiencies as factors that hinder the smooth conduct of practical activities le Remperaz and Calzada (2025). Heavy workloads and logistical

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challenges in forensic laboratories can delay laboratory sessions and limit students' hands-on engagement. (Masudi, 2023).

e. Limited Instructor Competence and Training

This theme shows that insufficient training and lack of familiarity with laboratory equipment among instructors affect their ability to effectively utilize available resources and deliver practical learning.

BC1 "May available naman na equipment... kaso di ako marunong pano gamitin." (Equipment is available but not known how to use).

PLT2 also added: "Wala akong specialization... di ko alam pano gamitin... puro theoretical." (No specialization and only theoretical knowledge).

These responses were supported by AC1 who stated that, "Ah, isa pa jan yung Lack of familiarity with the equipment so I struggled with adjusting the correct camera settings like ISO, shutter speed, and aperture." (One thing is the Lack of familiarity with the equipment so I struggled with adjusting the correct camera settings like ISO, shutter speed, and aperture)

The responses of the participants reveal that limited instructor competence and training also affect the proper utilization of laboratory equipment in forensic science. As expressed by BC1, even when equipment is available, it cannot be fully used due to lack of knowledge on how to operate it. Similarly, PLT2 shared that without proper specialization or training, instruction tends to focus more on theory rather than practical application. This limits

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the use of laboratory resources and reduces opportunities for students to engage in hands-on learning.

The findings imply that institutions should invest in continuous training and professional development for instructors handling forensic science subjects. Providing workshops, seminars, or hands-on training sessions can help improve instructors' skills and confidence in using laboratory equipment. Schools may also consider assigning instructors based on their area of specialization to ensure more effective teaching. By strengthening instructor competence, institutions can maximize the use of available laboratory resources and provide students with better practical learning experiences. Instructional effectiveness in criminology is highly dependent on pedagogical preparedness (Albrando and Revisa 2023).

f. Lack of Laboratory Management

This theme points to the absence of proper laboratory management practices, including personnel and storage systems, which may lead to safety issues and inefficient use of laboratory resources.

According to BC3: "Walang appropriate laboratory personnel... kanya kanya ang professor. Magkakaroon ng contamination ng reagents ..." (No appropriate laboratory personnel assigned, may lead to contamination of reagents)

BC3 also added "Walang proper storage like ref" (No proper storage for chemicals, like refrigerator).

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The responses of the participants show that the lack of proper laboratory management is a challenge in the effective use of laboratory equipment in forensic science. As shared by BC3, the absence of assigned laboratory personnel leads instructors to manage materials on their own, which can result in poor handling and possible contamination of reagents. This situation increases the risk of errors and affects the reliability of laboratory results. In addition, the lack of proper storage facilities, such as refrigerators for chemicals, further contributes to the problem, as materials may not be stored under the right conditions.

The findings imply that institutions should strengthen their laboratory management systems by assigning dedicated laboratory personnel who can oversee the proper handling, storage, and maintenance of equipment and materials. Having trained staff can help prevent contamination, ensure safety protocols are followed, and support instructors during laboratory activities. Additionally, schools should provide appropriate storage facilities, such as proper cabinets and refrigeration units, to maintain the quality of chemicals and other materials. Improving laboratory management practices will help create a safer, more organized, and more effective learning environment for both instructors and students.

Masudi (2023) stated, "Forensic laboratories face infrastructure inadequacies and limited resources, which impede effective practical engagement", supporting the need to enhance and expand laboratory facilities. Similarly, Santos (2024) reported, "Limitations in personnel, knowledge, and infrastructure prevent optimal use of forensic resources, reinforcing the present finding that institutional investment and improved scheduling

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strategies are essential to provide sufficient hands-on experience for students in forensic science instruction”.

Meta – Inferences

The combined results from the document analysis, quantitative data, and qualitative responses show that the use of laboratory equipment in forensic science subjects generally helps criminology students develop their skills. However, there are clear differences in terms of availability, functionality, ease of use, and management that limit its full effectiveness. The document analysis shows that while basic laboratory equipment is available in all institutions, none of them fully meet CHED standards. There are noticeable gaps in completeness and availability, especially in areas like forensic photography, questioned documents, and forensic ballistics.

The quantitative results show that most students and instructors agree that the laboratory equipment is functional, easy to use, and safe. This means that the equipment is helpful in supporting hands-on activities and in allowing students to apply what they learn. However, there are still some common issues, such as lack of digital integration, problems with compatibility, minor equipment malfunctions, and limited safety gear. There are also differences in how students and instructors view the equipment, with instructors usually noticing more technical problems than students.

The qualitative findings support these results by showing the actual challenges students experience during laboratory activities. These include lack of familiarity with the

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equipment, limited tools, poor laboratory conditions, and difficulty in performing technical tasks. These problems match the identified themes such as lack of laboratory equipment, uncondusive laboratory facilities, and limited instructional support. This shows that even if the equipment is generally seen as usable, students still face difficulties that can affect their learning.

Generally, the findings show that laboratory equipment is important in helping students improve their practical skills, thinking ability, and application of forensic techniques. However, the existing problems in equipment availability, technology use, and laboratory management reduce its full impact. Because of this, there is a need to improve instruction by upgrading laboratory equipment, improving laboratory management, strengthening instructor training, and making sure everything meets CHED standards. These improvements will help create a more effective and modern learning environment for criminology students in the Province of Albay.

5. Proposed forensic science instructional framework

The primary output of this study is the development of a Forensic Science Instructional Improvement Framework, which serves as a strategic guide for enhancing the delivery of forensic science education. This framework emphasizes the integration of theoretical knowledge and practical application through the effective utilization of laboratory equipment. It is designed to support instructors in improving their teaching practices while simultaneously enriching students' learning experiences.

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The framework is composed of the following components; program enhancement, facility and equipment upgrading, faculty and personnel development, instructional strategies, and monitoring and evaluation into actionable and systematic reforms. Through this approach, it addresses the identified challenges in forensic science instruction and ensures that criminology students in the Province of Albay acquire not only foundational knowledge but also the essential skills and competencies required for professional forensic practice.

Conclusions

This study came up with the major findings on the status, utilization, impact, and challenges of forensic science laboratory equipment across three institutions. The conclusions are presented per objective as follows:

1. There are variations in the status of forensic science laboratory equipment in terms of availability, adequacy, and serviceability across the identified institutions exhibiting notable deficiencies in several forensic laboratory areas.
2. Laboratory equipment utilization is generally characterized by acceptable levels of functionality, ease of operation, and safety, although consistency in application varies.
3. The utilization of laboratory equipment has a strong and positive impact on criminology students' competencies, particularly in practical skills acquisition, critical thinking, and application of forensic techniques.

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4. Multiple challenges persist in the utilization of forensic science laboratory equipment, affecting its optimal use in instructional delivery.
 5. The development of a structured forensic science framework is warranted to strengthen the competencies of criminology students.

Recommendations

Based on the conclusions of the study, the following recommendations are presented to address the identified gaps and strengthen the implementation of forensic science laboratory instruction across the three institutions. Each recommendation is aligned with a specific conclusion and identifies the responsible persons, intended beneficiaries, and the rationale for its implementation.

1. The Commission on Higher Education (CHED) may strictly enforce, monitor, and evaluate compliance among higher education institutions offering the Criminology program in relation to the prescribed forensic science laboratory equipment standards under CMO No. 21, Series of 2005, to ensure the adequacy, availability, and serviceability of essential forensic laboratory equipment across all institutions.
2. Higher education institutions offering the Criminology program may standardize and strengthen the implementation of forensic science laboratory protocols through regular faculty training, skills enhancement programs, and uniform laboratory procedures to

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ensure consistent utilization of laboratory equipment in terms of functionality, ease of operation, and safety across all forensic science subjects.

3. The Commission on Higher Education (CHED), in coordination with higher education institutions offering the Criminology program, may institutionalize and strengthen competency-based forensic science laboratory instruction by integrating standardized laboratory performance outcomes, structured hands-on training requirements, and outcome-based assessment mechanisms to ensure the consistent development of students' practical skills, critical thinking, and application of forensic techniques.

4. Accreditation bodies, in coordination with the Commission on Higher Education (CHED), may implement comprehensive quality assurance, monitoring, and improvement mechanisms for Criminology programs, including regular evaluation of forensic science laboratory facilities, assessment of equipment adequacy and functionality, and enforcement of compliance with laboratory standards, to address persistent challenges affecting the optimal utilization of forensic science laboratory equipment in instructional delivery.

5. The Commission on Higher Education (CHED), in coordination with curriculum developers and higher education institutions offering the Criminology program, may adopt and institutionalize the proposed forensic science framework to guide the enhancement of forensic science education through program improvement, facility and equipment upgrading, faculty and personnel development, instructional strategy enhancement, and strengthened monitoring and evaluation mechanisms.

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