Research Article

Beyond Criminological Theories: How Forensic Crime Laboratory Practice Enhances Criminology and Security Studies Education

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Abstract: This study addresses the significant pedagogical gap between theoretical criminology and security studies education (CSSE) and the applied realities of forensic science within the justice system. Despite graduates often forming the first line of personnel at crime scenes, curricula have traditionally underutilised forensic laboratories as experiential learning resources. This research proposes a structured model for integrating forensic crime laboratory practice into Criminology and Security Studies Education (CSSE), grounded in Kolb's experiential learning cycle. Employing a qualitative case-study design, the research conducted a directed content analysis of publicly available academic curricula and professional standards documents from bodies like Organization of Scientific Area Committees (OSAC), and European Network of Forensic Science Institutes (ENFSI). The analysis identifies how core forensic crime principles, methodological rigor, evidence reliability, chain of custody can be explicitly integrated to bridge the theory-practice. Findings advocate for a transformative pedagogical framework where hands-on forensic crime engagement facilitates concrete experience, reflective observation, abstract conceptualisation, and active experimentation. This model cultivates essential professional competencies, including scientific literacy, critical evidence evaluation, ethical reasoning, and communication skills. The study concludes by proposing an organogram for a tertiary institutions-based forensic criminology laboratory, detailing a hybrid structure of academic oversight, scientific operations, and student integration. This structured approach aims to enhance educational outcomes and workforce readiness, ultimately positioning the forensic laboratory as a vital nexus for synthesizing science, theory, and justice in CSSE.

Keywords: Criminology and Security Studies Education (CSSE), Experiential Learning Theory (ELT), Pedagogy, Forensic Crime Laboratory, Tertiary Institutions.

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1. Introduction

Criminology and Security Studies Education (CSSE) has evolved considerably to meet the growing complexities of the discipline and the demands of the workforce. Universities and colleges have a crucial role in preparing their students for the workforce by fostering a problem-solving mindset, strengthening critical and reflective skills, and providing the foundational knowledge necessary for the profession (Wals & Jickling, 2002, as cited in kakar 2025). This responsibility is particularly vital in CSSE, where theory and practice is essential for ensuring workforce readiness. Traditionally, CSSE curricula were designed to meet the needs of criminal justice systems, often taught by practitioners who prioritized job-readiness but placed less emphasis on practical foundations and analytical skills (Albanese & Tartaro, 2024). In response, lecture-based teaching methods were introduced to strengthen theoretical knowledge; however, they were often insufficient in cultivating practical skills or critical thinking (Che et al., 2021).

Aim and Objectives

The aim of the study is to develop, implement, and evaluate a structured pedagogical model for integrating forensic laboratory practice into Criminology and Security Studies Education (CSSE). The specific objectives include:

i. To Propose Structure of Forensic Criminology Laboratory in Tertiary Institutions

ii. To investigates how hands-on forensic criminology engagement can bridge the theory-practice gap, enhance educational outcomes, and develop professional competencies

2. Statement of the Problem

Despite their critical role in the justice system, forensic crime laboratories remain a significantly underutilized educational resource within criminology and security studies curricula. These programs have traditionally prioritized theoretical frameworks, often at the expense of practical, experiential learning. Consequently, a pedagogical gap exists between abstract criminological theory and the applied scientific and procedural realities of criminal investigation and evidence handling. This disconnect is problematic, as graduates of these programs increasingly form the first line of personnel at crime scenes and within legal proceedings, yet they often lack foundational, hands-on competencies in evidence collection, preservation, analysis, and interpretation.

The central problem, therefore, is the absence of a structured pedagogical model that systematically bridges theoretical criminological education with the practical, experiential learning afforded by criminological contexts. While experiential learning theory particularly Kolb's (2015) cycle provides a validated framework for knowledge creation through concrete experience and reflection, its application within forensic laboratory settings for criminology students remains underdeveloped. This gap limits students' ability to synthesize scientific principles with legal procedures, investigative practices, and ethical considerations, ultimately hindering their professional preparedness for the interdisciplinary demands of modern public and private security sectors.

Thus, this research addresses the problem of how to effectively integrate hands-on forensic science experiences into criminology and security studies education. It seeks to interrogate how structured engagement with forensic laboratories, conceptualized through experiential learning theory, can transform pedagogy, enhance educational outcomes, and prepare students for diverse professional pathways by placing them at the vital intersection of theory and practice, science and justice.

3. Literature Review

Core Principles of Experiential Learning in Forensic Contexts: A Pedagogical Framework for Criminology and Security Studies

The integration of forensic laboratory experiences into criminology and security studies education (CSSE) represents a transformative pedagogical shift from purely theoretical instruction to applied, experiential learning. Grounded in David Kolb's experiential learning cycle, this approach bridges the gap between criminological theory and the practical realities of the justice system. The application of this framework is not merely about teaching forensic techniques, but about using the forensic context as a dynamic microcosm to develop critical professional competencies and a nuanced understanding of how science interacts with law, ethics, and society (kolb, 2023).

The successful adaptation of experiential learning theory to forensic education hinges on deliberately engaging students in each of Kolb's four stages within a criminological

context:**(i)Concrete Experience:** This foundational stage involves direct, hands-on engagement with forensic processes. For criminology students, this means moving beyond textbooks to process mock evidence, conduct presumptive tests, or analyze simulated crime scene materials. These experiences demystify forensic science, providing future professionals who are often the "first line of personnel" at crime scenes with the contextual understanding needed to make informed decisions about evidence collection and preservation. For instance, a basic grasp of DNA analysis principles empowers an investigator to recognize valuable biological evidence at a scene, even without expertise in the underlying biochemistry.**(ii)Reflective Observation**: This stage transforms technical exercises into deep learning by prompting students to critically examine their experiences through multiple lenses: scientific, legal, ethical, and social. Structured reflection, often through guided writing, asks students to connect their lab work to broader issues. After fingerprint analysis, for example, students might reflect on cognitive bias in pattern matching or the role of fingerprint misidentification in wrongful convictions. This reflection links practice to critical criminological themes like systemic bias and the social impact of forensic technologies.**(iii)Abstract Conceptualistion:** Here, students synthesize their practical observations and reflections with broader theoretical frameworks. Specific laboratory experiences become gateways to exploring criminological theory. Analyzing a controlled substance might lead to discussions on drug policy, social harm reduction, and racial disparities in enforcement. This stage also fosters epistemological understanding, helping students critically assess how forensic knowledge is constructed and validated within the justice system and how its misinterpretation can lead to miscarriages of justice.**(iv)Active Experimentation**: The cycle culminates with students applying their integrated knowledge to novel problems or scenarios. This could involve designing improved evidence protocols, developing community education materials, or proposing policy reforms based on forensic science's capabilities and limitations. This phase mirrors professional demands, preparing students to adapt scientific knowledge to complex real-world situations while navigating legal and ethical constraints.

Implementing the Framework: Pedagogical Models
Several structured models effectively operationalised this experiential cycle within forensic contexts:

 i. **Structured Internships:** Placing students in working forensic labs or related justice agencies offers authentic immersion. These programs, like those at the University of Iowa, provide insight into organizational dynamics, chain of custody procedures, and interagency collaboration, complemented by reflective seminars to process the experience.
ii. **Simulation-Based Learning:** Mock crime scenes and simulated evidence analysis offer controlled, low-stakes environments for hands-on learning. Using resources like the National Science Teaching Association's case studies, students can practice procedural rigor and confront ethical dilemmas, such as interpreting degraded evidence, without the pressures of real casework.
iii. **Collaborative Research Projects:** Engaging students in original forensic-focused inquiry—evaluating a technique's effectiveness or analyzing evidence patterns develops critical appraisal skills. These projects teach students to navigate the ethical considerations of forensic research while applying methodological rigor.
iv. **Case Study Analysis:** Examining real cases, especially those involving forensic controversies or wrongful convictions, powerfully facilitates reflective observation and abstract conceptualization. Students learn to critique how forensic findings were communicated, interpreted, and potentially misused within the legal process.

Curriculum Integration: Bridging Disciplines

Effective integration requires moving beyond isolated exercises to thoughtful curriculum design that bridges criminology and forensic science:

i. **Forensic Modules:** Incorporating targeted lab sessions, guest lectures from practitioners, or forensic case studies into existing criminology courses provides flexible integration. This approach, as used at Marquette University, demonstrates how forensic science operates within the real-world constraints of the justice system.

ii. **Interdisciplinary Collaborations:** Formal partnerships between criminology and natural science departments allow students to benefit from specialized expertise. This mirrors the inherently interdisciplinary nature of the field, where scientific methods must integrate with legal standards and social science insights.

iii. **Forensic Studies Minors/Capstones:** Structured minors or concentrations offer dedicated pathways for criminology students to gain scientific foundation. Capstone projects allow for the synthesis of this knowledge, requiring students to address complex, real-world problems at the science-justice interface, such as evaluating new forensic technologies for a local police department.

Developing Essential Professional Competencies

Beyond theoretical knowledge, forensic experiential learning cultivates indispensable professional skills:

i. **Scientific Literacy & Evidence Evaluation:** Students learn to interpret technical reports, understand methodological limitations, and assess the probative value of evidence, developing an "appreciative skepticism" crucial for justice professionals.

ii. **Critical Thinking & Analytical Reasoning:** The structured problem-solving of lab work following protocols, considering alternatives, justifying conclusions—hones the analytical skills required for criminological research and policy analysis.

iii. **Communication & Testimony Skills:** Through exercises like mock testimony, students practice translating complex scientific information for non-specialist audiences, a vital skill for anyone presenting analysis or evidence within the justice system.

iv. **Ethical Reasoning & Professional Judgment:** Grappling with forensic dilemmas (e.g., bias, quality assurance, ambiguous results) in a lab setting builds the ethical framework necessary for responsible practice, directly addressing concerns highlighted by wrongful conviction research.

v. **Collaboration & Interprofessional Skills:** Team-based lab activities mirror the collaborative reality of criminal investigations, teaching students to integrate diverse perspectives and work effectively across disciplinary boundaries.

Navigating Implementation Challenges

Successful implementation requires addressing several key challenges:

Resource Constraints: Lack of facilities or equipment can be mitigated through partnerships with operational labs, law enforcement, or by using simulation-based and virtual alternatives.

Curriculum Integration: Resistance from theory-focused programs can be overcome by aligning forensic experiences directly with criminological learning outcomes (e.g., using drug analysis to inform drug policy discussions) and investing in faculty development.

i. **Ethical & Legal Considerations:** Protocols must ensure the ethical use of materials, respect for confidentiality, and sensitivity when simulating crime-related content, with close faculty oversight akin to internship supervision.

ii. **Assessment Difficulties:** Moving beyond traditional exams, assessment should employ reflective writing, portfolio development, case analyses, and practical demonstrations to holistically evaluate the integration of knowledge, skill, and judgment.

iii. **Equity & Inclusion:** Programs must be designed accessibly for students with diverse academic backgrounds. This includes scaffolded instruction and explicitly addressing the field's historical inequities to foster a critical and socially aware perspective.

In summary, the core principles of experiential learning in forensic contexts advocate for a pedagogical model where the forensic laboratory becomes an active learning space for criminology students. By systematically moving through concrete experience, reflective observation, abstract conceptualization, and active experimentation within this setting, students achieve a powerful synthesis. They not only grasp the scientific underpinnings of evidence but also develop the critical, ethical, and professional competencies needed to navigate and improve the justice system. This approach addresses a critical gap in traditional education, preparing graduates to be more effective, discerning, and ethically grounded professionals whether they pursue careers in investigation, law, policy, or security. The ultimate goal is a transformative reimagining of criminology education that places the forensic laboratory at the vital intersection of theory and practice, science and justice.

4. Theoretical Framework

Experiential Learning Theory (ELT), based on the work of Dewey (1938) and Piaget (1970), was formalized by Kolb (1984) as a structured model of experiential learning (Kolb & Kolb, 2005). Grounded in active engagement, reflection, and practical application, ELT enhances knowledge retention, problem-solving skills, and adaptability (Boggu & Sundarsingh, 2019; Kolb, 2014). This cyclical learning process consists of four stages: Concrete Experience (direct engagement in activities), Reflective Observation (analyzing experiences), Abstract Conceptualization (developing theories based on reflection), and Active Experimentation (applying concepts in new contexts). This iterative process ensures learning is both reflective and action-oriented, reinforcing comprehensive understanding through continuous application (Thurgood, 2020).

While ELT has been widely applied in fields, such as medicine and law to enhance professional competencies (Kong, 2021), its integration into criminology and security studies education (CSSE) has been more gradual. Experiential pedagogy (Kolb, 1984) introduced methods, such as internships, simulations, service-learning, and case studies to bridge classroom learning with real-world application (Bradberry & De Maio, 2019). Research evaluating ELT pedagogy has consistently shown that active learning significantly enhances student engagement and long-term academic success (Crandalla et al., 2021; George et al., 2015; Michael, 2006; Prince, 2004).

The synthesis of experiential learning theory with forensic crime laboratory education offers a transformative approach to criminology and security studies pedagogy. By moving beyond traditional theoretical instruction to incorporate hands-on engagement with forensic science principles and practices, educational programs can better prepare students for the complex realities of modern justice and security systems. This integrated approach recognizes that forensic science is not merely a technical specialty but a fundamental component of criminology and security studies and criminal justice ecosystems one that future professionals across multiple disciplines must understand to perform their roles effectively.

The experiential learning cycle with its emphasis on concrete experience, reflective observation, abstract conceptualization, and active experimentation provides a robust framework for designing forensic laboratory experiences that develop both practical

competencies and critical understanding. When implemented through structured internships, simulation-based learning, collaborative research, or case-based approaches, these experiences help students bridge the gap between theoretical knowledge and professional application. They cultivate essential skills including scientific literacy, critical thinking, ethical reasoning, and interdisciplinary collaboration all increasingly valuable in a criminological landscape increasingly shaped by technological advancement and evidence-based practice.

Looking forward, several promising directions emerge for further development of this educational synthesis. First, advances in virtual and augmented reality technologies offer new possibilities for creating immersive forensic experiences without the resource constraints of physical laboratories. Second, the growing emphasis on interdisciplinary collaboration in both education and practice suggests increasing opportunities for formal partnerships between criminology programs, criminal justice system and forensic science departments. Third, the ongoing reassessment of forensic laboratory and methodologies in light of scientific validity concerns creates important teaching opportunities for examining the relationship between science, law, and justice. Finally, the expansion of forensic applications beyond traditional law enforcement contexts into areas such as human rights investigations, environmental protection, and cybersecurity suggests broader relevance for forensic crime education and also across multiple security domains (Wang, 2023).

As criminology and security studies continue to evolve as academic disciplines, the integration of experiential learning through forensic laboratories represents a significant opportunity to enhance both educational quality and professional relevance. By grounding theoretical understanding in practical experience, and by connecting social science perspectives with scientific methodologies, this approach prepares students not just to understand criminal justice systems, but to contribute thoughtfully to their improvement. In doing so, it addresses the fundamental challenge articulated in forensic education literature: preparing a diverse range of future professionals to engage competently and ethically with the scientific dimensions of justice. The continued development and refinement of this pedagogical synthesis will play an important role in shaping the next generation of criminology and security professionals equipped not only with theoretical knowledge but with the practical wisdom necessary to navigate the complex intersections of science, law, and society.

Applications ofForensics Laboratory into Criminology and Security Studies Education (CSSE)

As criminology and Security Studies Education(CSSE) evolved, the need to integrate theory with practice became increasingly evident, making experimental learning theory a suitable framework to address these emerging demands. This led to its incorporation into the CSSE curriculum through internships, simulations, and service-learning. However, reliance on these assignments has posed challenges, including inconsistent placements and resource constraints. To overcome these limitations, innovative strategies such as compulsory forensics laboratory practice for all tertiary institution for each student, field works, and crime vignette evaluations have been introduced to enhance critical thinking and comprehension (Cotugno, 2018). The use of professional opinion surveys, reflective analyses, and crime vignette evaluations in (CSSE) has been shown to enhance critical thinking and comprehension. Cotugno (2018) examined the impact of reflective writing assignments on criminology students and found that engaging in reflective analyses allowed them to critically assess their assumptions and deepen their understanding of criminal justice concepts. Similarly, Howes (2017) reported that case studies, which often incorporate crime vignette evaluations, improve critical thinking skills among criminal

justice students. The analysis of student responses revealed that certain topics resonated more strongly, fostering deeper engagement and critical reflection. Howes (2017) added that students demonstrated personally relevant meaning-making, developing more nuanced perspectives on crime and justice, as well as more compassionate rationales for pursuing careers in the field. These results highlight the importance of incorporating experiential learning strategies to strengthen critical thinking in criminology education. They demonstrate the impact of experiential learning in addressing contemporary challenges in (CSSE), preparing students with the essential skills required to navigate the complexities of the criminal justice workforce.

Proposed Structure of Forensic Criminology Laboratories in Tertiary Institutions
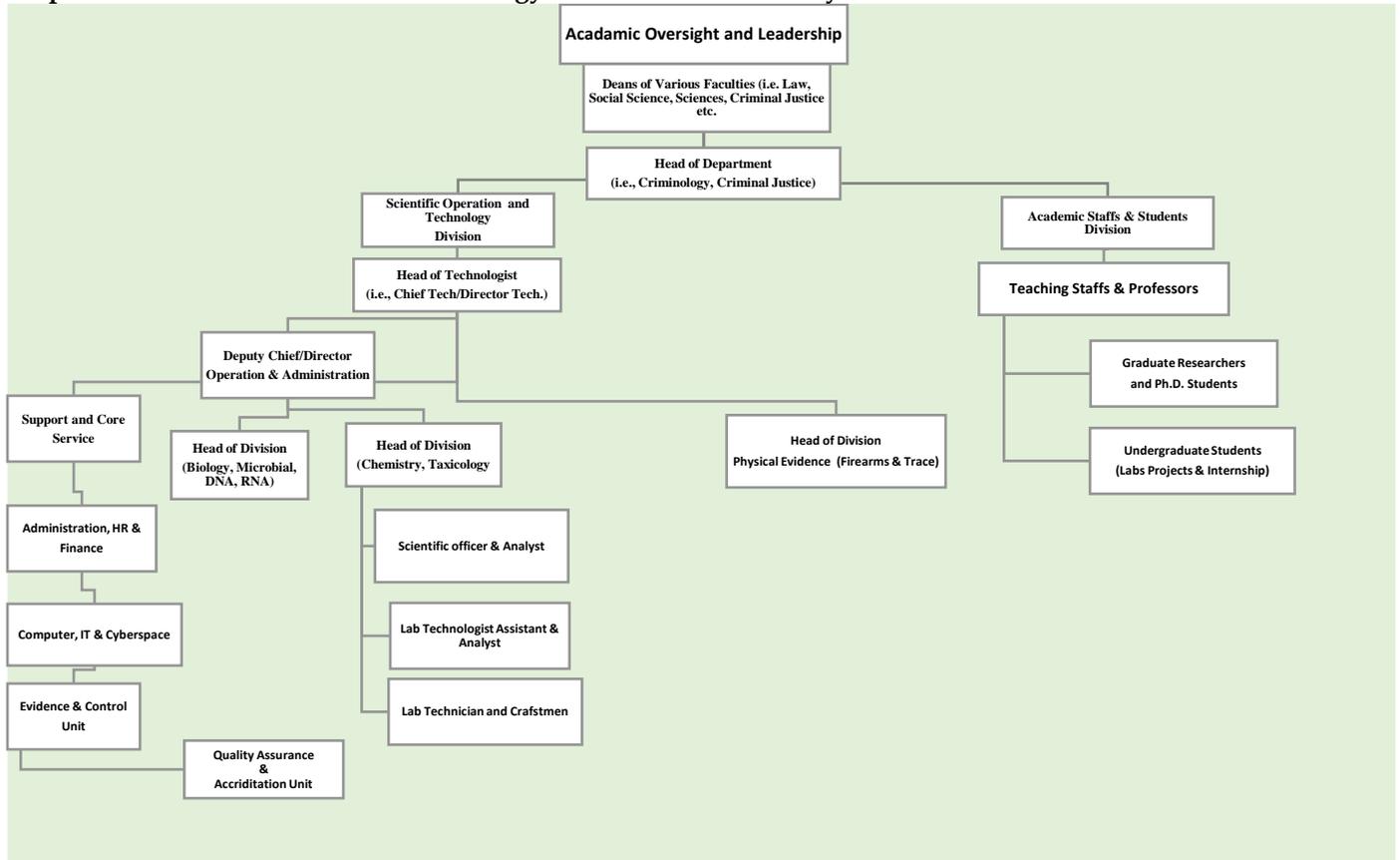
Source: (Research Work, 2026)

Analysis of the Forensic Crime Laboratory Organogram in Tertiary Institutions
This organogram outlines the structure of a forensic criminology laboratory embedded within a tertiary education institution (polytechnic, mono-technics, college or university). Its hybrid nature combines academic leadership, scientific operations, and student involvement.

1. Academic Oversight & Leadership: This is the level of strategic and administrative oversight. A **"Plan of Priority"** (e.g., for the College of Social Sciences, Science, Law, Forensics & Criminology) will be established. This body is responsible for setting a strategic plan—whether weekly, by semester, or by academic session—which may originate from the institution's senate. The laboratory's goals must align with this overarching academic plan.
The "Department/Unit Head of Finance" controls the budget for all departments, including the forensic laboratory. The "Laboratory Chief and Academic Head" oversees daily laboratory activities. This combined role fulfills the duties of both a senior scientist

(Chief/Principal) and an academic (Professor), ensuring scientific integrity, setting research direction, and linking laboratory operations to the department chair.

2. Scientific Operations &Technology Division: This represents the core functional management of the laboratory's work. It is structured into three apparent columns:

Column 1. Technical Divisions & Senior Management: Thehead of division Forensic Molecular Analysis (FMA)(e.g., Chemistry, Toxicology, Microbiological, DNA and RNA etc.). Also Head of Division Company / Technology: e.g., "Digital& Technology" (Computer and Cyberspaceforensics, Instruments). Deputy Chief / Associate Director should focus on daily Operations & Administration.

Column 2. Specialised Units & Administrative Support: Head of physical defense (Firearms, Trace), and physical evidence covers firearms/tool marks and trace evidence (hairs, fibers, paint). Administrator, HR & Finance: Handles personnel, payroll, and lab-specific budgeting. IT & Database Management: Critical for lab information management systems (LIMS), data integrity, and digital evidence.

Column 3. Quality & Core Services: Support & Core Services: Shared resources (glassware, media preparation, stock). Defence Control & Control Unit: Almost certainly the "Evidence Control Unit" – the central hub for receiving, logging, storing, and distributing all evidence (chain of custody). Quality Assurance / Accreditation Manager. Ensures all procedures meet standards (e.g., ISO 17025) for court-admissible results. Essential for credibility.

3. Academic Students & Division
This is what makes it distinctively an educational lab."Teaching Faculty & Research Professor"**:** Academics who may not run daily lab divisions but teach courses and conduct research using the lab facilities. Graduate Researchers & PhD Students: The primary research workforce. They conduct thesis projects under faculty supervision, driving the lab's innovation. Undergraduate Students (Laboratory, Projects, Internships), Involved in capstone projects, summer research, or internship programs, getting hands-on experience.

Major 5 Components in a University Forensic Criminology Organogram
 i. **Academic Oversight Structure:** This shows reporting lines to the university's administration, such as the Dean of Science or Faculty of Criminal Justice. It anchors the lab within the academic institution.
ii. **Laboratory Leadership:** The core management, including the Laboratory Director (often a senior professor), Deputy/Operations Director, and a Quality Assurance Manager. This trio is responsible for scientific standards, daily operations, and accreditation.
iii. **Scientific Divisions/Units:** The operational heart of the lab, organized by forensic discipline. Common divisions include Biology/DNA, Chemistry/Toxicology, and Physical Evidence (e.g., firearms, toolmarks). Each unit is led by a Head/Supervisor.
iv. **Technical & Support Staff:** This layer includes the Scientific Officers/Analysts who conduct casework and the Laboratory Technicians/Assistants who support them.
 v. **Academic & Research Integration:** This uniquely academic branch includes Teaching Faculty, Research Professors, and students (Postdoctoral, Graduate, and Undergraduate Researchers).

5. Methodology
This study employed a qualitative, case-study design using secondary data to analyse how forensic crime laboratory practice reform criminology pedagogy. The primary data

sources were publicly available, accredited academic program curricula and syllabi from various forensics sciences, criminal justice and criminology programs alongside official practice documents from professional forensic bodies (e.g., Organization of Scientific Area Committees [OSAC], and European Network of Forensic Science Institutes [ENFSI]). A directed content analysis was conducted on these textual documents. The analytical framework was derived from core criminological paradigms (e.g., rational choice, social disorganisation) and key forensic science processes (e.g., chain of custody, validation, interpretation). Analysis involved systematic coding to identify explicit and implicit integrations of forensic laboratory principles such as methodological rigor, evidence reliability, and cognitive bias into theoretical and applied criminology education. Themes were developed regarding how these integrations potentially reframe theoretical assumptions and enhance practical competency in security studies. As a documentary analysis of publicly accessible materials, this research was exempt from IRB review. All source materials were cited appropriately, and no confidential or proprietary information was used. The study's limitations include its reliance on documented curricula rather than observed classroom teaching.

6. Discussion

This research demonstrates that the systematic integration of forensic laboratory practice, governed by professional standards (OSAC, ENFSI), provides a robust solution to the persistent theory-practice gap in Criminology and Security Studies Education (CSSE). The findings validate that forensic science offers an ideal experiential context for operationalising Kolb's cycle, transforming abstract criminological theory into tangible competencies. The proposed pedagogical model, culminating in a structured hybrid organogram for tertiary institutions, is not merely an additive curriculum element but a transformative reorientation of CSSE.

The discussion must acknowledge, however, that successful implementation faces significant hurdles. The proposed organogram, while logically sound, requires substantial institutional investment and interdisciplinary collaboration that may challenge traditional departmental silos. Furthermore, the study's reliance on documentary analysis, though methodologically sound, points to a critical limitation: it establishes a conceptual and structural blueprint but cannot empirically verify the educational outcomes or workforce readiness it promises. Future research must therefore transition from proposal to pilot implementation, employing longitudinal, mixed-methods approaches to measure the model's impact on student skill acquisition, critical thinking, and professional preparedness.

Ultimately, this study shifts the discourse by positioning the forensic laboratory as an essential pedagogical nexus rather than a technical annex. It argues convincingly that engaging with the scientific method, chain of custody, and ethical dilemmas of evidence prepares graduates not just for specific jobs, but to be critically literate participants in a justice system increasingly dependent on and challenged by forensic science. The model's true value lies in fostering a generation of professionals equipped with an "appreciative skepticism," capable of synthesizing scientific rigor with social science insight at the vital intersection of science and justice.

7. Recommendations

Based on the findings and discussion, the following recommendations are proposed to advance the integration of forensic laboratory practice into CSSE and guide future action:
1. For Tertiary Institutions & Curriculum Designers:

i. **Adopt a Phased Implementation Strategy:** Begin by integrating discrete forensic modules (e.g., evidence handling, mock testimony) into core criminology courses, as outlined in the pedagogical models, before scaling to a full minor or dedicated laboratory.

ii. **Pilot the Proposed Hybrid Organogram:** Establish a working group to adapt the proposed laboratory structure to local institutional contexts. Seek seed funding for a proof-of-concept lab focused on one discipline (e.g., crime scene investigation or digital evidence).

iii. **Develop Interdisciplinary Partnerships:** Formalize collaborations between criminology/departments of social sciences and chemistry, biology, or computer science departments to share resources, expertise, and teaching responsibilities.

2. For Educators & Faculty Development:

i. **Invest in Faculty Training:** Provide professional development workshops to equip criminology faculty with the foundational scientific knowledge and pedagogical skills to facilitate experiential forensic learning, even without a lab science background.

ii. **Co-create Assessment Rubrics:** Move beyond traditional exams by developing standardized assessment tools (e.g., for reflective portfolios, case study analyses, practical demonstrations) that evaluate the integrated competencies the model aims to develop.

3. For Policymakers & Accreditation Bodies:

i. **Incentivise Curriculum Innovation:** Funding bodies and educational ministries should create grants specifically for developing interdisciplinary, practice-based curricula in CSSE that address workforce readiness gaps.

ii. **Update Program Accreditation Standards:** Professional and educational accreditors for criminology and security studies should consider incorporating standards that encourage or require experiential, science-based learning components linked to professional forensic standards.

4. For Future Research:

i. **Conduct Longitudinal Impact Studies:** Future research must move from conceptual design to empirical testing. Implement pilot programs based on this model and use mixed-methods, longitudinal studies to measure their impact on student learning outcomes, skill retention, and graduate employability.

ii. **Explore Technological Solutions:** Investigate the cost-effectiveness and pedagogical efficacy of virtual reality (VR) simulations and digital forensics platforms as scalable alternatives or supplements to physical laboratories to overcome resource barriers.

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