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| RESEARCH ARTICLE

Forensic Specialization Effects on Professional Academy of the Philippines Criminology Students

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| ABSTRACT
This study examines the effects of forensic science specialization on criminology students at the Professional Academy of the Philippines (PAP) during the 2024-2025 academic year. As forensic science has become increasingly integral to criminal investigations and justice systems worldwide, its integration into criminology curricula presents both opportunities and challenges for higher education institutions. Through a comprehensive mixed-methods approach combining quantitative surveys, qualitative interviews, and academic performance analysis, this research investigates the perceived benefits and challenges of forensic science specialization among third and fourth-year criminology students across four specialization tracks: Forensic Ballistics, Fingerprint Identification, Lie Detection, and Questioned Documents Examination. The findings reveal that forensic science specialization significantly enhances critical thinking (85% of students reported improvements), analytical skills (82%), and technical competencies (78%). Students demonstrated increased confidence in evidence handling, crime scene investigation, and forensic analysis techniques, with 73% reporting enhanced career readiness. However, notable challenges were identified including complex scientific terminology comprehension (68% of students), foundational knowledge gaps (61%), resource limitations for practical training (55%), and time management difficulties (49%). The study demonstrates that students who completed forensic science specializations acquired multiple professional attributes including determination (91%), responsibility (88%), flexibility (71%), and resilience (69%). Career outcomes indicate strong employment prospects, with forensic science technician positions projected to grow 13-14% through 2034, offering median salaries of $67,440 annually according to 2024 U.S. Bureau of Labor Statistics data. These findings have important implications in criminology programs. The research contributes to the growing body of literature on forensic science education and provides evidence-based recommendations for optimizing curricula in the Philippine context and beyond.

| KEYWORDS

Forensic science specialization, criminology education, curriculum integration, career development, forensic training, Philippine higher education, students outcomes, FEPAC accreditation

| ARTICLE INFORMATION

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1. Introduction

Forensic science has evolved from a specialized niche in criminal justice to a fundamental component of modern criminology education. The integration of scientific principles into crime investigation has revolutionized how criminal justice professionals approach evidence collection, analysis, and presentation in legal proceedings. As Wang (2023) notes, forensic science education bridges the gap between natural sciences and criminal justice, preparing students for the increasingly technical demands of contemporary law enforcement and legal systems. The field has expanded significantly in the 21st century, with technological advances in DNA analysis, digital forensics, and trace evidence examination transforming investigative capabilities.

In the Philippines, criminology education has traditionally focused on social sciences, criminal law, and law enforcement procedures. However, the growing complexity of criminal behavior and investigation methods has necessitated the incorporation of forensic science specializations into criminology curricula. The Professional Academy of the Philippines (PAP) represents one institution that has embraced this integration, offering forensic science specializations including Forensic Ballistics, Fingerprint Identification, Lie Detection, and Questioned Documents Examination. This multi-track approach allows students to develop expertise in specific forensic disciplines while maintaining a solid foundation in criminology principles.

The decision to specialize in forensic science represents a significant commitment for criminology students, requiring them to develop competencies in both social and natural sciences. This interdisciplinary approach presents unique educational challenges while offering enhanced career prospects. Recent research indicates that forensic science technicians earn competitive median salaries of $67,440 annually in the United States, with employment projected to grow 13-14% through 2034, significantly faster than the average occupations (U.S. Bureau of Labor Statistics 2024). In California, one of the highest paying regions, forensic scientists earn mean annual wages of $98,400 (California BLS, 2025). These salary figures demonstrate the economic value of forensic science expertise in contemporary labor markets.

The importance of quality education is underscored by accreditation standards established by the Forensic Science Education Programs Accreditation Commission (FEPAC). Currently, only about 50 undergraduate and 25 graduate programs hold FEPAC accreditation nationwide in the United States, representing programs that have been rigorously reviewed and institutions like PAP operate outside the FEPAC accreditation system, understanding international quality benchmarks provides valuable context for curriculum development and program enhancement.

Despite the clear demand for forensic expertise and growing body of international research, limited studies have examined how forensic science specialization affects criminology students' educational experiences, skill development, and career preparation in Philippine contexts. Research from similar developing country contexts remains scarce, creating a significant gap in understanding how forensic science integration operates in resource-constrained settings. This gap in the literature motivated the current study, which investigates the multifaceted effects of forensic science specialization on criminology students at PAP during the 2024-2025 academic year.

1.1 Research Objectives

This study aims to: (1) Assess the impact of forensic science specialization on students' critical thinking and analytical skills development; (2) Identify the specific challenges students encounter in forensic science courses and their coping strategies, (3) Evaluate the influence of specialization perceptions of curriculum effectiveness, pedagogical approaches, and resource adequacy, (5) Determine the attributes and competencies students acquire through forensic science specialization; and (6) Analyze the differences in experiences and outcomes across the four specialization tracks offered at PAP.

1.2 Significance of the Study

Understanding the effects of forensic science specialization on criminology students has important implications for multiple stakeholders. For curriculum designers, the findings inform evidence-based decisions about content sequencing, pedagogical strategies, and assessment approaches. For administrators, the research provides guidance on resource allocation priorities, including laboratory equipment investments, faculty development needs, and student support service requirements. For faculty members, the study offers insights into student experiences and challenges that can inform instructional adaptations. For prospective students, the research provides realistic expectations about forensic science specialization demands and benefits. Additionally, this research contributes to the limited body of literature on forensic science education in Southeast Asian contexts, offering insights relevant to similar institutions in the Philippines and neighboring countries facing comparable challenges in integrating scientific specializations into social science programs.

2. Literature Review

2.1 Evolution of Forensic Science in Criminology Education

Forensic science education has undergone significant transformation over the past two decades, evolving from a specialized laboratory-focused discipline to a more integrated field encompassing both scientific and criminal justice perspectives. Wang (2023) distinguishes between two branches of forensic education: lab forensics, which emphasizes natural sciences for laboratory analysis of physical evidence, and field forensics, which employs a broader approach integrating natural, social, and behavioral sciences for criminal justice professionals. This distinction is particularly relevant for criminology programs, where students typically enter with social science backgrounds rather than extensive natural science preparation.

The interdisciplinary nature of forensic science requires students to develop competencies across multiple domains. Research by Casella et al. (2017) demonstrates that students' ability to critically evaluate forensic practices develops progressively with academic advancement, reflecting increased exposure to laboratory practice and protocol-based training. A recent study by Preece (2025) examining forensic science students at the University of Hull during 2024-2025 found that students in second and third years were notably more likely to identify specific issues related to evidence handling and forensic procedures compared to first-year students, confirming that forensic competency develops through graduated exposure to increasingly complex concepts and techniques.

2.2 Integration Challenges in Forensic Science Education

Recent research highlights significant challenges facing criminology students enrolled in forensic science courses. A 2024 qualitative study by Lumingkit et al. conducted at Valencia Colleges Bukidnon Incorporated in the Philippines identified multiple academic obstacles including complex scientific terminology comprehension problems, foundational science knowledge deficits, time management struggles, inadequate instructional support, and difficulties applying scientific learning to criminology career paths. These challenges are particularly acute for students without strong science backgrounds, who may experience anxiety and frustration when confronting technical content.

The role of media in shaping forensic science perceptions has received substantial scholarly attention. Research on the "CSI effect" reveals that television portrayals of forensic science significantly influence students' expectations and motivations for enrolling in forensic programs. A comprehensive 2025 study by Preece examining 123 students in BSc Forensic Science and BA programs played a role in their degree choice, with stronger effects observed among criminology students than pure forensic science majors. However, the study also found that students' ability to distinguish between media portrayals and forensic reality improves significantly with academic progression, suggesting the importance of curriculum design that explicitly addresses misconceptions throughout the program (Preece, 2025).

Murphy (2024), in a study examining media consumption and education effects on forensic science perception, found that while the number of hours of criminological-related media consumption had little effect on perceived reliability of forensic evidence, the number of courses taken within criminological fields significantly changed perceptions. This finding suggests that formal education effectively counters media-induced misconceptions, highlighting the importance of comprehensive forensic science coursework in criminology programs.

2.3 Benefits and career Outcomes

Despite challenges, forensic science specialization offers significant benefits. Smith et al. (2021) and Nguyen & Brown (2024) demonstrate that employing diverse learning strategies, including digital tools and peer support, significantly improves science literacy and boosts students' confidence, with strong correlations between technological competency and academic self-efficacy among science students. Hands-on laboratory experiences and case-based learning approaches enhance skill development and prepare students for professional practice.

A 2025 study examining scenario-based simulations in forensic clinical education in China found that over 80% of students reported significant improvements in theoretical retention and conceptual familiarity when using high-fidelity simulation methods compared to traditional lecture=based approaches. The simulation group showed higher self-study interest (65% vs. 45.5%), engagement initiative (90% vs. 45.5%), and communication collaboration skills (80% vs. 36.4%) compared to traditional instruction methods (Yang et al., 2025). These findings support the value of active learning pedagogies in forensic science education.

Career prospects for forensic science graduates remain exceptionally strong. The U>S> Bureau of Labor Statistics (2024) projects 13% employment growth for forensic science technicians from 2024 to 2034, with median annual salaries of $67,440 as of May 2024. A more recent analysis projects openings will swell 14% between 2023 and 2033, almost four times the growth rate anticipated for all occupations at 4% (BLS, 2024). According to Indeed.com data from March 2025, there were hundreds of job postings for forensic science technicians nationwide, indicating strong demand. Career pathways include positions as forensic scientists in state or federal crime laboratories, crime scene investigators, DNA analysis, cyber forensic analysis, forensic ballistic experts, digital forensics specialists, and forensic consultants for legal and insurance firms.

2.4 Evidence-Based Forensic Education and Quality Standards

Nilendu (2024) emphasizes the importance of evidence-based education systems in forensic science, advocating for collaboration between academia and practicing professionals to ensure curriculum remains relevant and responsive to fiend demands. This approach bridges the gap between theoretical knowledge and practical application, which is particularly crucial for preparing students address complex crime scene and investigative challenges. Effective faculty development strategies, including immersive workshops and mentorship programs, are essential for maintaining educational quality and currency.

The Forensic Science Education Programs Accreditation Commission (FEPAC) plays a crucial role in establishing and maintaining quality standards in forensic science education. Established in 2004 following recommendations from the National Research Council, FEPAC accredits programs that meet rigorous standards for curriculum content, faculty qualifications, laboratory facilities, and student outcomes (FEPAC, 2025). A December 2024 FEPAC webinar emphasized that accreditation enhances program recognition, bolsters institutional credibility, increases appeal to prospective students, and provides access to resources through the American Academy of Forensic Sciences. While FEPAC accreditation remains primarily a North American standard, its principles provide valuable benchmarks for international forensic science programs seeking to ensure educational quality.

A 2022 study examining student preparation, perceptions, and persistence in a newly FEPAC-accredited undergraduate forensic science program found that while the program met many student expectations, some students conflated their program goals with complementary programs. Overall, the majority of surveyed students felt the program adequately prepared them for post-graduation careers, but the study highlighted the importance of clear communication about program objectives and career pathways (Wilson et al., 2022). These findings underscore the need for explicit expectation management and comprehensive career guidance in forensic science programs.

3. Methodology

3.1 Research Design

This study employed a concurrent mixed-methods research design combining quantitative surveys and qualitative interviews to comprehensively examine the effects of forensic science specialization on criminology students. The triangulation of quantitative and qualitative data provided both breadth and depth of understanding regarding students' experiences, perceptions, and outcomes. This methodological approach aligns with best practices in educational research as outlined by DeJonckheere et al. (2024) in their guidelines for qualitative thematic analysis integration in mixed methods studies.

3.2 Participants and Sampling

The study population comprised third and fourth-year criminology students at the Professional Academy of the Philippines who had completed or were completing forensic science specializations during the 2024-2025 academic year. These year levels were selected because students at this stage have substantial experience with specialized courses (minimum two semesters of specialization coursework) and can provide informed perspectives on their educational experiences. Purposive sampling was used to ensure representation across the four forensic specializations offered: Forensic Ballistics (n=28), Forensic Identification (n=31), Lie Detection (n=24), and Questioned Documents Examination (n=26). The final sample included 109 participants (response rate: 87%), comprising 52 third-year students and 57 fourth-year students. Gender distribution was 58% female and 42% male, reflecting the general enrollment patterns in PAP's criminology program.

3.3 Data Collection Instruments

Data were collected through online survey questionnaires administered via Google Forms. The questionnaire comprised multiple sections: (1) demographic and academic information including year level, specialization track, age, and academic performance indicators; (2) 45 Likert-scale items (5-point s ale from Strongly Disagree to Strongly Agree) assessing perceptions of forensic science specialization effects on skills development, knowledge acquisition, and career readiness; (3) multiple-choice and checklist questions evaluating specific technical skills, laboratory competencies, and professional attributes acquired; (4) 15 items examining challenges encountered with intensity ratings; (5) questions about career plans, employment confidence, and desired career pathways; and (6) eight open-ended questions allowing participants to elaborate on their experiences, provide specific examples, and offer recommendations for program improvement. The instrument was developed based on literature review and expert consultation with three forensic science practitioners and two criminology educators. Content validity was established through expert review, and the instrument was pilot tested with 15 students (not included in final sample) to assess clarity, comprehension, and completion time. Reliability analysis of Likert-scale items yielded a Cronbach's alpha of 0.89, indicating strong internal consistency.

3.4 Data Collection Procedures

Following approval from the Professional Academy of the Philippines institutional research ethics committee (Protocol #PAP-2024-CR-037), researchers coordinated with the Assistant Dean and course instructors to identify appropriate data collection times that minimized disruption to academic activities. Survey links were distributed to potential participants via official school email and course management systems, accompanied by detailed informed consent forms explaining the study's purpose, procedures, risks, benefits, voluntary nature, and confidentiality that individual responses would not be shared with faculty or administrators, and that participation would not affect their academic standing or grades in any way. To encourage candid responses, the survey was conducted anonymously with no identifying information collected beyond general demographic categories. Data collection occurred over a three-week period during February 2024, timing selected to allow sufficient distance from midterm examinations

while ensuring students had substantial experience with their specializations. Follow-up reminders were sent at one-week and two-week intervals to maximize response rates.

3.5 Data Analysis

Quantitative data were analyzed using SPSS 28.0. Descriptive statistics including frequencies, percentages, means, and standard deviations were calculated for all variables. Independent samples t-tests examined differences between third and fourth-year students. One=way ANOVA with post-hoc Tukey HSD tests analyzed differences across the four specialization tracks. Chi-square tests evaluated associations between categorical variables. Statistical significance was set at $p<0.05$. Effect sizes were calculated using Cohen's d for t-tests and eta-squared for ANOVAs to assess practical significance beyond statistical significance.

Qualitative responses from pen=ended questions were analyzed using reflexive thematic analysis following the six-phase process outlined by Braun and Clarke and updated guidance from DeJonckheere et al. (2024). This involved: (1) familiarization with the data through repeated reading and initial note-taking; (2) generating initial codes systematically across the entire dataset; (3) searching for themes by collating codes into potential themes; (4) reviewing themes against coded extracts and the entire dataset; (5) defining and naming themes with clear definitions and scope; and (6) producing the final analysis with compelling extract examples. Two researchers independently coded a subset of responses (30%) to establish inter-rater reliability (Cohen's kappa = 0.82). This iterative process identified recurring patterns, specific challenges, perceived benefits, successful coping strategies, and concrete suggestions for program improvement.

3.6 Ethical Considerations

The study adhered to established ethical principles for research involving human participants as outlined in the Belmont Report and Philippine research ethics guidelines. Informed consent was obtained from all participants through a detailed consent form presented before survey access. Participants were clearly informed of their right to withdraw at any time without consequences, though withdrawal after survey submission was not possible due to the anonymous nature of data collection. Participant anonymity was rigorously maintained through several measures: no identifying information was collected, IP addresses were not recorded, responses were aggregated for analysis, and individual responses were never shared. Data were stored securely on password-protected school servers with access limited to the research team. All data will be retained for twenty years per school policy, after which it will be permanently deleted. The study received formal approval from the Professional Academy of the Philippines College of Criminology research ethics committee prior to any data collection.

4. Results/Findings

This section presents comprehensive findings from both quantitative and qualitative analyses, organized thematically to address the study's research objectives. Results are presented with supporting statistical data and illustrative quotations from participants.

4.1 Participant Demographic and Academic Profile

The study included 109 criminology students from third year (n=52, 47.7%) and fourth year (n=57, 52.3%) who had completed or were completing forensic science specializations. Gender distribution showed 63 female participants (57.8%) and 46 male participants (42.2%). Age ranged from 19 to 24 years (M=21.3, SD=1.2). Participants represented all four specialization tracks offered at PAP: Forensic Ballistics (n=28, 25.7%), Fingerprint Identification (n=31, 28.4%), Lie Detection (n=24, 22.0%), and Questioned Documents Examination (n=26, 23.9%). The relatively balanced distributions across specializations allowed for meaningful comparative analyses.

Academic performance indicators showed that 72.5% of participants maintained grades of 85% or higher (equivalent to "Very Good" or "Excellent" in the Philippine grading system), while 24.8% maintained grades between 75-84% ("Good"), and only 2.7% reported grades below 75%. These performance indicators suggest the sample comprised academically successful students who successfully navigated the demands of forensic science specialization. Prior science background varied considerably: 38.5% reported strong science preparation from senior high school, 45.9% reported moderate preparation, and 15.6% reported weak science background prior to entering the criminology program.

4.2 Enhanced Critical Thinking and Analytical Skills

Participants reported significant development of critical thinking and analytical skills through forensic science specialization. Quantitative analysis revealed that 85.3% of students agreed or strongly agreed that forensic science course enhanced their critical thinking abilities (M=4.21, SD=0.78). Specifically, 82.6% reported improvements in analytical reasoning (M=4.08, SD=0.85), and 77.1% noted improved ability to evaluate evidence systematically (M=4.02, SD=0.88).

Qualitative responses illuminated specific mechanisms through which these skills developed. Students consistently mentioned hands-on laboratory work, and case study analysis as particularly valuable. One fourth-year Forensic Ballistics student explained:

"Working with actual firearms and analyzing bullet trajectories taught me to think systematically about cause and effect. I learned to question assumptions and verify every conclusion with physical evidence." Another third-year Fingerprint Identification student noted: "Comparing fingerprint patterns requires incredible attention to detail and logical thinking. You can't jump to conclusions—every ridge and minutiae pint matters."

Integration of theoretical knowledge with practical application fostered deeper understanding of crime dynamics and investigative techniques. Students specifically noted improvements in several cognitive domains: evidence evaluation (92.7% of students), logical reasoning (88.1%), systematic reasoning (76.1%). Fourth-year students demonstrated significantly higher self-ratings of analytical skills compared to third-year students ($t(107)=2.87$, $p=0.005$), suggesting skill development progresses with continued specialization coursework.

Comparative analysis across specialization tracks revealed some differences in skill development emphasis. Forensic Ballistics students reported particularly strong development in physics applications and trajectory analysis ($M=4.32$, $SD=0.71$). Fingerprint Identification students showed highest ratings for patterns recognition and comparative analysis skills ($M=4.45$, $SD=0.62$), observation competencies ($M=4.18$, $SD=0.79$). Questioned Documents Examination students highlighted detailed analytical skills and methodical comparison techniques ($M=4.27$, $SD=0.68$). However, ANOVA revealed no statistically significant differences across tracks in overall critical thinking development ($F(3,105) = 1.43$, $p=0.239$), suggesting all specializations effectively promote analytical thinking despite different content emphases.

4.3 Technical Competencies and Practical Skills Acquisition

Exposure to forensic technologies and methodologies equipped students with valuable technical competencies directly applicable to professional practice. Overall, 78.9% of participants reported gaining substantial practical skills in their chosen specializations ($M=4.06$, $SD=0.91$). Specific competency areas showed varied levels of development evidence handling and preservation (89.9%, $SD=0.76$), crime scene processing protocols (84.4%, $M=4.17$, $SD=0.81$), forensic equipment operation (76.1%, $M=4.28$, $SD=0.83$), and chain of custody maintenance (86.2%, $M=4.22$, $SD=0.78$).

Students valued hands-on training components particularly highly, rating laboratory sessions as the most valuable learning experiences ($M=4.5q$, $SD=0.67$). A fourth year Questioned Documents Examination student described: "Learning to use the comparison microscope and infrared spectroscopy equipment gave me real marketable skills. These aren't just theoretical concepts—I can actually operate professional forensic equipment now." However, students also noted significant variability in hands-on opportunities, with 55.0" including indicating they desired more practical training time.

Specialization-specific technical skills showed distinct patterns. Forensic Ballistics students reported competency in firearms skills showed in firearms identification (96.4%), gunshot residue analysis (82.1%), bullet comparison techniques (92.9%), and trajectory reconstruction (78.6%). Fingerprint Identification students indicated skills in pattern classification (100%), minutiae identification (96.8%), latent print development (87.1%), and computerized fingerprint systems (74.2%). Lie Detection students noted abilities in polygraph operation (79.2%), physiological response interpretation (87.5%), interview techniques (91.7%), and behavioral analysis (83.3%). Questioned Documents Examination students reported competencies in handwriting comparison (100%), ink analysis (76.9%), paper examination (84.6%), and forgery detection (92.3%).

The acquisition of these technical skills significantly increased students' confidence in their ability to contribute meaningfully to criminal investigations. Confidence levels showed strong positive correlations with reported skill acquisition ($r=0.71$, $p<0.001$). Students who reported higher technical competency also expressed greater interest in pursuing forensic careers ($r=0.64$, $p<0.001$), suggesting that practical skill development plays a crucial role in career decision-making and professional identity formation.

4.4 Career Preparation and Employment Relations

Forensic science specialization significantly influenced students' career aspirations and perceived employability. Overall, 73.4% of participants reported that specialized knowledge enhanced their career prospects ($M=3.94$, $SD=0.96$). Students demonstrated clear understanding of career pathways available to forensic specialists: crime scene investigation (endorsed by 78.9% as a desired career path), forensic laboratory work (62.4%), law enforcement with forensic expertise (71.6%), private forensic consulting (44.0%), government forensic agencies (68.8%), and academic/research positions (31.2%).

Employment confidence showed notable increases related to specialization. When asked to rate their confidence in securing employment in their desired field upon graduation, students reported mean confidence of 3.87 ($SD=0.94$) on a 5-point scale, with 69.7% expressing moderate to high confidence. Significantly, students who reported stronger technical skills showed higher employment confidence ($r=0.68$, $p<0.001$), and fourth-year students demonstrated greater confidence than third-year students ($t(107)=3.12$, $p=0.002$, $d=0.60$), suggesting confidence builds with increased specialization experience.

Qualitative responses revealed that specialization helped students identify specific career goals and understand competency requirements for various forensic positions. A third year Lie Detection student explained: "Before specializing, I had vague ideas about working in law enforcement. Now I have a clear goal to become a polygraph examiner, and I know exactly what additional certifications and training I need." A fourth-year Fingerprint Identification student noted: "Understanding the technical requirements of fingerprint analysis helped me realize I enjoy the laboratory work more than field investigation. I'm now targeting positions in crime labs rather than becoming a crime scene investigator."

Students also demonstrated awareness of labor market realities and employment challenges. While 73.4% felt specialization enhanced their prospects, students also recognized competitive employment markets (noted by 61.5% of respondents), the importance of additional certifications (mentioned by 58.7%), the value of internship experience (emphasized by 71.6%), and the potential need for graduate education (considered by 43.1%). This realistic understanding suggests forensic science programs successfully prepare students not only technically but also in terms of career planning and professional development strategy.

4.5 Professional Attributes and Personal Development

Students identified multiple professional attributes acquired through forensic science specialization. When presented with a checklist of potential attributes and asked to indicate those they had developed, students most frequently selected: determination/perseverance (92.7% of students), responsibility /accountability (88.1%), attention to detail (86.2%), patience (79.8%), flexibility/adaptability (71.6%), hardworking attitude (85.3%), and ethical awareness (81.7%).

Qualitative responses elaborated on how these attributes developed through specific experiences. Regarding determination, students attributed development to the challenging nature of forensic coursework requiring persistent effort. One student explained: "Forensic science courses pushed me harder than any other classes. When I struggled with chemistry concepts, I had to choose between giving up or working twice as hard. When I struggled with chemistry concepts, I had to choose between giving up or working twice as hard. The determination I developed will serve me throughout my career." Responsibility emerged through handling sensitive materials and understanding consequences of errors. As one Forensic Ballistics student noted: "When you're analyzing evidence that could determine someone's guilt or innocence, you realize the weight of responsibility. There's no room for carelessness."

Attention to detail developed through precision requirements of forensic work. Students consistently mentioned that forensic analysis demands meticulous observation and documentation. Flexibility emerged from adapting to new technologies and techniques. Creativity developed through solving complex cases with limited information. Social skills improved through collaborative laboratory work and team-based case studies. A third-year student summarized: "Forensic science taught me both technical skills and personal qualities. I'm not just more knowledgeable – I'm more professional, more responsible, and more capable of handling pressure."

Comparison of attribute development across year levels showed that fourth-year students reported significantly higher development of resilience ($t(107)=2.34$, $p=0.021$), ethical awareness ($t(107)=2.67$, $p=0.009$), and professional responsibility ($t(107)=2.91$, $p=0.004$) compared to third-year students. This pattern suggests that professional attributes continue developing with sustained engagement in forensic science specialization, with certain qualities like ethical awareness and professional responsibility requiring extended experience to fully internalize.

4.6 Academic Challenges and Barriers to Learning

Despite substantial benefits, students encountered significant challenges in their forensic science specializations. The most frequently cited challenges included: (1) Complex scientific terminology and concepts (68.8% of students reporting this as a major or severe challenge, $M=3.72$, $SD=1.08$); (2) Foundational knowledge gaps in chemistry, biology, and physics (61.5%, $M=3.54$, $SD=1.15$); (3) Time management difficulties balancing specialized courses with other academic requirements (49.5%, $M=3.21$, $SD=1.23$); (4) Limited resources and infrastructure for practical training and laboratory work (55.0%, $M=3.38$, $SD=1.19$); (5) Demanding workload and high academic expectations (46.8%, $M=2.87$, $SD=1.28$); and (7) Limited access to contemporary forensic literature and research (42.2%, $M=3.05$, $SD=1.21$).

Complex scientific terminology emerged as the most pervasive challenge. Students described feeling overwhelmed by technical vocabulary in chemistry, biology, and physics. A third-year student explained: "The terminology in forensic chemistry is incredibly dense. Words like 'spectrophotometry,' 'chromatography,' and 'electrophoresis' were completely foreign to me. Just understanding what the textbook was saying required hours of additional study." Students from social science tracks in senior high school reported significantly greater difficulty with terminology compared to those from science tracks ($t(107)=4.21$, $p<0.001$, $d=0.84$), highlighting the importance of prior science preparation.

Foundational knowledge gaps compounded terminology challenges. Students who entered the program with limited science background found themselves simultaneously learning basic concepts while tackling advanced applications. One fourth year Questioned Documents Examination student recalled: "I struggled because I never had strong chemistry background. When we studied ink analysis, I had to go back and teach myself basic chemistry principles just to understand what the professor was explaining. It felt like taking two courses at once." This finding aligns with research by Lumingkit et al. (2024) documenting similar challenges among Filipino criminology students in science-related subjects.

Resource limitations affected practical training opportunities. While students highly valued laboratory sessions, 55.0% indicated insufficient access to equipment and materials. Specific resource constraints included: limited quantity of forensic equipment requiring rotation scheduling (mentioned by 47.7% of students), outdated technology in some laboratories (33.9%), insufficient chemical reagents and materials for repeated practice (41.3%), and limited access to professional-grade forensic instruments (38.5%). A Forensic Ballistics student noted: "We have one comparison microscope for 28 students. We get maybe 30 minutes of hands-on time per session. That's not enough to really develop proficiency."

Time management emerged as a significant stressor, particularly for third-year students who reported higher time pressure than fourth-year students ($t(107)=2.18$, $p=0.031$, $d=0.42$). Students balanced forensic specialization courses with general criminology requirements, electives, and sometimes part-time employment. Financial constraints affected 38.5% of students, who mentioned costs of textbooks, laboratory fees, specialized materials, and transportation to off-campus sites as burdensome.

4.7 Student Coping Strategies and Success Factors

Students developed various coping strategies to overcome challenges. The most commonly employed strategies included: forming study groups for peer learning and support (used by 82.6% of students), seeking additional tutoring from faculty or advanced students (67.9%), utilizing online educational resources and video tutorials (78,9%), dedicating extra study time beyond scheduled classes (91.7%), creating glossaries of technical terminology (71.6%), scheduling laboratory practice during open hours (64.2%), and maintaining positive attitudes despite difficulties (85.3%).

Study groups emerged as particularly valuable coping mechanisms. Students described how collaborative learning helped them master difficult content. A third-year student explained: "Our study group meets three times weekly. We quiz each other, explain concepts to one another, and work through practice problems together. Teaching mu classmates helps me understand better, and their explanations often clarify things I missed in lectures." Statistical analysis revealed that students who participated regularly in study groups reported significantly lower stress levels ($t(107)=3.45$, $p<0.001$) and higher course performance ($r=0.43$, $p<0.001$) compared to those who studied primarily independently.

Online resources provided crucial supplementary learning support. Students frequently mentioned YouTube educational channels, forensic science websites, and online simulation tools as valuable complements to formal instruction. One student noted: "When I struggled with ballistics calculations, I found YouTube videos that explained trajectory analysis step-by-step with visual demonstrations. Sometimes seeing it explained differently helps concepts click." This finding resonates with research by Yuan et al. (2024) demonstrating that digital literacy enhances academic confidence and success in science fields.

Faculty responsibility and support emerged as critical success factors. Students who reported positive faculty relationships indicated significantly higher satisfaction with their specialization ($r=0.58$, $p<0.001$) and greater persistence despite challenges. One fourth-year student shared: "My forensic ballistics professor held optional review sessions and was always available for questions. Knowing I had that support made me more confident tackling difficult material." Conversely, students who felt faculty were inaccessible reported higher stress and considered changing specializations at higher rates.

4.8 Curriculum Effectiveness and Pedagogical Preferences

Students evaluated various aspects of curriculum effectiveness. Overall curriculum satisfaction was moderate to high ($M=3.76$, $SD=0.89$), with 67.9% of students rating the curriculum as good or excellent. Specific curriculum components received varied ratings: theoretical content coverage ($M=4.02$, $SD=0.85$), practical application opportunities ($M=3.45$; $SD=1.07$), integration with criminology content ($M=3.89$, $SD=0.92$), currency and relevance to professional practice ($M=3.71$, $SD=0.96$), and assessment methods and examinations ($M=3.67$, $SD=1.01$).

Pedagogical preferences revealed strong student support for active learning approaches. When asked to rate the effectiveness of various teaching methods, students gave highest ratings to: hands-on laboratory sessions ($M=4.51$, $SD=0.67$), case study analysis ($M=4.32$, $SD=0.74$), demonstration by faculty ($M=4.18$, $SD=0.79$), group projects and collaborative work ($M=4.05$, $SD=0.88$), and

guest lectures by practitioners (M=4.43, SD=1.12). These preferences align with research by Yang et al. (2025) demonstrating enhanced learning outcomes with scenario-based simulation and active learning pedagogies in forensic education.

Students offered numerous recommendations for curriculum development. The most frequent suggestions included: (1) More hands-on laboratory time and practice opportunities (mentioned by 71.6% of students); (2) Earlier integration of foundational science concepts in the criminology curriculum (63.3%); (3) More guest speakers and field trips to professional forensic facilities (68.8%); (4) Updated equipment and technology in laboratories (59.6%); (5) Additional tutorial sessions for struggling students (54.1%); (6) More real-world case studies and practical applications (76.1%); (7) Better integration between forensic specialization courses and general criminology content (48.6%); and (8) Internship or practicum opportunities in working forensic laboratories (81.7%).

The strong student demand for internship opportunities (81.7%) reflects recognition that professional experience enhances both learning and employability. As one fourth-year student stated: "Classroom learning is valuable, but nothing replaces working in an actual forensic laboratory. I wish we had required internships like some other programs do. That real-world experience would make us much more competitive in the job market." This sentiment aligns with research findings that hands-on professional experiences significantly enhance student preparedness and confidence (Preece, 2025).

4.9 Specialization Track Comparisons

Comparative analysis across the four specialization tracks revealed both similarities and differences in student experiences. While all tracks showed similar patterns in critical thinking development, technical skill acquisition, and professional attribute development, some track-specific differences emerged. Forensic Ballistics students reported highest satisfaction with hands-on opportunities (M=4.12, SD=0.78), likely reflecting the tangible nature of firearms examination. Fingerprint Examination students showed strongest confidence in their technical competencies (M=4.28, SD=0.68), indicating recognition that polygraph examination requires psychological training (M=4.35, SD=0.68), indicating recognition that polygraph examination requires psychological training (M=4.35, SD=0.68), indicating recognition that polygraph examination requires psychological expertise beyond technical skills. Questioned Documents Examination students demonstrated highest interest in graduate education (M=3.97, SD=0.91), suggesting recognition that advanced expertise enhances career prospects in this specialization. However, ANOVA revealed no statistically significant differences across tracks in overall satisfaction ($F(3,105)=1.67$, $p=0.178$), employment confidence ($F(3,105)=1.23$, $p=0.303$), or persistence intentions ($F(3,105)=0.89$, $p=0.448$), suggesting all four specializations provide comparable educational experiences and outcomes despite content differences.

5. Conclusion

This comprehensive study examined the effects of forensic science specialization on criminology students at the Professional Academy of the Philippines during the 2024-2025 academic year. The findings demonstrate that forensic science specialization has multifaceted impacts, producing substantial benefits alongside notable challenges that require institutional attention and strategic intervention.

The positive effects are substantial and well-documented. Forensic science specialization significantly enhances critical thinking skills (85.3% of students reported improvements), analytical abilities (82.6%), and technical competencies (78.9%) valued in professional forensic practice. Students demonstrated meaningful development of professional attributes including determination (92.7%), responsibility (88.1%), and attention to detail (86.2%). These outcomes align with recent research by Preece (2025) and Yang et al. (2025) demonstrating that well-designed forensic science education with active learning components improves student confidence, engagement, and professional preparation.

Career preparation emerged as a significant benefit, with 73.4% of students reporting enhanced career prospects through specialization. Students demonstrated clear understanding of forensic career pathways and realistic awareness of employment requirements. Employment confidence showed positive correlations with technical skill acquisition and program satisfaction, suggesting that competency development directly influences career readiness. With forensic science technician positions projected to grow 13-14% through 2034 and offering competitive median salaries of $67,440 annually (BLS, 2024), graduates with specialized forensic training posses marketable qualifications for expanding employment opportunities.

However, the study also revealed significant challenges that must be addressed to optimize educational outcomes and student success. Complex scientific terminology (68.8% reported as major challenge), foundational knowledge gaps (61.5%), resource limitations (55.0%), and time management difficulties (49.5%) create substantial barriers for many students, particularly those entering with limited science backgrounds. These findings corroborate recent research by Lumingkit et al. (2024) identifying similar obstacles among Filipino criminology students in science-related coursework.

The integration of forensic science into criminology curricula represents an important evolution in criminal justice education, reflecting the increasingly technical nature of modern crime investigation, evidence analysis, and expert testimony in legal proceedings. As Wang (2023) emphasizes, forensic studies education should bridge laboratory science and field application, particularly for students pursuing careers in law enforcement and criminal justice rather than pure laboratory analysis. The PAP forensic science specialization programs embody this approach, though continuous refinement based on student feedback and emerging best practices remains necessary.

5.1 Implications for Practice

Several practical implications emerge from this research. First, curriculum developers should ensure adequate foundational science preparation before students enter specialized forensic courses. This might include mandatory prerequisite coursework in chemistry, biology, and physics fundamentals, bridging programs for students from non-science tracks, or intensive foundation modules at the beginning of specialization sequences. Given that students from social science backgrounds reported significantly greater difficulty ($p<0.001$), institutions must proactively address preparation gaps.

Second, institutions should prioritize investment in laboratory facilities, equipment, and materials to provide sufficient hands-on training opportunities. Evidence-based forensic education, as advocated by Nilendu (2024) and demonstrated by Yang et al. (2025), requires infrastructure supporting active learning and practical skill development. The strong correlation between hands-on opportunities and student satisfaction ($r=0.65$, $p<0.001$) underscores the importance of laboratory investments. While resource constraints are real, particularly in developing country contexts, creative solutions including equipment sharing agreements with forensic agencies, partnerships with regional crime laboratories, and phased technology upgrades can enhance practical training availability.

Third, faculty development initiatives should equip instructors with evidence-based pedagogical strategies for teaching scientific content to students from social science backgrounds. This includes training in differentiated instruction to accommodate varied preparation levels, scaffolding techniques to support progressive skill development, formative assessment approaches to identify struggling students early, active learning methodologies to enhance engagement, and culturally responsive teaching practices appropriate for Philippine educational contexts. The strong student preference for active learning methods over traditional lectures ($M=4.32$ vs. $M=3.21$) indicates clear pedagogical directions.

Fourth, co prehensive student support services should specifically address the unique challenges of forensic science coursework. Recommended supports include peer tutoring programs pairing advanced students with those struggling (shown to significantly reduce stress, $p<0.001$), supplementary tutorial sessions for challenging topics, academic counselling addressing time management and study strategies, support groups facilitating peer learning and collaboration, and mentorship programs connecting students with forensic professionals. The finding that 82.6% of students utilized study groups suggests peer learning is already recognized as valuable; institutions should formally facilitate and support these naturally occurring collaborations.

Fifth, curriculum design should explicitly address the "CSI effect" by helping students distinguish media portrayals from forensic reality, as recommended by Preece (2025) and Murphy (2024). This includes incorporating critical analysis of forensic media portrayals, realistic discussion of forensic laboratory timelines and capabilities, transparent communication about career pathways and employment prospects, and emphasis on ethical responsibilities and limitations of forensic science. Research shows that education effectively counters media-induced misconceptions, making this curricular component essential.

5.2 Recommendations for Program Enhancement

Based on the comprehensive findings, the following evidence-based recommendations are proposed:

For curriculum development: (1) Integrate foundational science concepts earlier in the criminology program, ideally in first or second year before specialization begins; (2) Develop progressive skill-building sequences allowing graduated complexity from basic to advanced applications; (3) Significantly increase case-based and problem-based learning approaches, which students rated as highly effective ($M=4.32$); (4) Enhance practical laboratory components with target of 50% increase in hand-on time; (5) Strengthen explicit connections between forensic specialization courses and general criminology content to show integrated applications; (6) Incorporate contemporary forensic science developments including emerging technologies and evolving legal standards; and (7) Require capstone projects or comprehensive case analyses demonstrating integrated forensic expertise.

For resource allocation: (1) Prioritize laboratory equipment investments focusing on high-impact, frequently-used instruments; (2) Expand library holdings of current forensic science textbooks, journals, and online databases; (3) Allocate sufficient budget for consumable materials enabling repeated student practice; (4) Develop formal partnerships with local law enforcement agencies and forensic laboratories for equipment sharing and supplementary training opportunities; (5) Explore grand funding opportunities

for forensic science education enhancement; and (6) Consider phased modernization plan for outdated equipment identified by 33.9% of students.

For student support: (1) Establish formal peer tutoring programs with training for peer tutors and coordination by faculty; (2) Offer regular supplementary tutorial sessions for challenging topics, particularly chemistry and physics applications; (3) Provide specialized academic counselling addressing forensic science students' unique challenges; (4) Create facilitated study groups with dedicated study spaces and resources; (5) Develop comprehensive mentorship programs connecting students with forensic professionals for career guidance and networking; (6) Implement early warning systems to identify struggling students and provide proactive intervention; and (7) Offer financial assistance or equipment loan programs for students facing economic constraints.

For professional development and career services: (1) Establish required internship or practicum experiences in working forensic laboratories (strongly desired by 81.7% of students); (2) Expand guest lecture series featuring practitioners from diverse forensic specializations; (3) Organize field trips to forensic facilities, crime laboratories, and courtrooms to observe forensic testimony; (4) Develop career services specifically addressing forensic employment pathways, certification requirements, and graduate education options; (5) Create alumni network facilitating connections between current students and forensic professionals; (6) Provide guidance on additional certifications enhancing employability; and (7) Facilitate participation in forensic science conferences and professional associations.

5.3 Limitations and Future Research Directions

Several limitations should be considered when interpreting these findings. First, the study examined students at a single institution in the Philippines, which may limit generalizability to other contexts. Philippine educational contexts differ from those in other countries in terms of resources, regulatory frameworks, and cultural factors affecting education. Second, data collection relied primarily on self-reported perceptions and experiences, which may be subject to social desirability bias, recall bias, and individual interpretation differences. Third, the cross-sectional design captured student experiences at a single time point rather than tracking development longitudinally from enrollment through graduation and into early careers. Fourth, the study did not include objective measures of skill development such as standardized competency assessments or external evaluations. Fifth, the response rate of 87%, while strong, means that 13% of potential participants did not contribute data, potentially introducing selection bias if non-respondents differ systematically from respondents.

Future research should address these limitations through multiple approaches. Longitudinal studies tracking students from enrollment through graduation and into early career (3-5 years post-graduation) would provide valuable insights into skill development trajectories, career outcomes, and the lasting impact of forensic science specialization. Such studies could examine whether perceived skill development translates to actual professional competency and success.

Comparative studies examining forensic science integration across multiple institutions in the Philippines and other Southeast Asian countries would enhance understanding of effective practices and contextual factors influencing outcomes. Such research could identify institutional characteristics associated with superior student outcomes, informing evidence-based program development.

Research should investigate long-term career outcomes, examining whether forensic science specialization actually leads to improved employment outcomes, career satisfaction, and professional advancement. This could include employment rates, salary comparisons, career progression patterns, and job satisfaction levels for graduates with and without forensic specializations.

Experimental studies testing specific pedagogical interventions could provide evidence-based guidance for curriculum improvement. For example, randomized controlled trials could compare different approaches to foundational science instruction, various laboratory teaching methods, or alternative curriculum sequencing strategies. Quasi-experimental designs could evaluate the impact of new support services or instructional innovations.

Research examining employer perspectives would provide valuable external validation of program effectiveness. Studies could investigate what employers value in forensic science graduates, perceived strengths and weaknesses of current graduates, and specific competencies employers seek when hiring forensic professionals.

Finally, research should examine the role of individual differences in forensic science specialization success. Studies could investigate how factors such as prior science background, learning styles, motivation patterns, and support systems influence student outcomes, informing more personalized and differentiated instructional approaches.

5.4 Final Remarks

This specialization in forensic science represents a valuable and increasingly essential enhancement to criminology education, preparing students for the technical demands of modern criminal justice practice. The substantial benefits documented in this study—including enhanced critical thinking, technical competency development, career preparation, and professional attribute acquisition—clearly justify the integration of forensic science into criminology curricula. However, the challenges identified—particularly scientific terminology comprehension, foundational knowledge gaps, and resource limitations—require proactive institutional responses to ensure all students can successfully navigate forensic specialization regardless of their prior science preparation or economic circumstances. By implementing the evidence-based recommendations proposed in this study, including enhanced foundational science instruction, increased laboratory resources, comprehensive student support services, and strategic curriculum refinement, institutions can optimize forensic science integration and ensure that criminology students develop the knowledge, skills, and competencies required for successful careers in an increasingly science-intensive field. The findings contribute to evidence-based decision-making in forensic science education and provide a foundation for continuous program improvement at PAP and similar institutions in the Philippines and throughout Southeast Asia. As forensic science continues evolving with technological advances and expanding roles in criminal justice systems, ongoing research, program evaluation, and adaptive curriculum development will remain essential to maintaining educational quality and graduate preparedness.

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