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Conceptual Competence in Homicide Investigations: Practitioner Understanding of Core Forensic Principles

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Abstract: Conceptual competence is central to the scientific and interpretive integrity of homicide investigations, yet limited empirical research has examined how frontline practitioners understand and apply foundational forensic principles. Existing literature often assumes practitioners possess adequate conceptual knowledge, overlooking the relationship between forensic theory and investigative decision-making. This study addresses this gap by exploring practitioners' interpretations of key forensic concepts, namely criminal investigation, forensic investigation, Locard's Exchange Principle, identification, and individualisation. An interpretivist qualitative design was employed, and semi-structured interviews were conducted with 36 crime scene practitioners, including detectives, first responders, crime scene investigators, and forensic personnel. Data were analysed thematically following Braun and Clarke's framework. The findings reveal that practitioner knowledge is largely fragmented and procedurally oriented, with limited conceptual depth. Significant misconceptions were identified, particularly in distinguishing identification from individualisation. Locard's Exchange Principle was understood primarily in intuitive terms, and forensic investigation was often reduced to evidence collection rather than interpretive analysis. Practitioners' understanding was shaped predominantly by experiential learning rather than by formal theoretical grounding. This study contributes to forensic and policing scholarship by providing empirical evidence of a persistent theory-practice gap in conceptual competence. It underscores the need for theory-informed training, improved interdisciplinary integration, and organisational reform to strengthen forensic reasoning, improve evidence interpretation, and support more reliable homicide investigations.

Keywords: Crime scene investigation; conceptual competence; forensic principles; homicide investigation; identification; individualisation; Locard's Exchange Principle.

Introduction

Forensic investigation is recognised as both a scientific and interpretive endeavour, requiring practitioners to apply foundational principles to reconstruct events accurately and maintain the integrity of criminal investigations. This is particularly critical in homicide investigations, where the consequences of evidentiary misinterpretation are far-reaching, affecting legal outcomes, ethical accountability, and public trust in the criminal justice system. Despite substantial advances in the technical capabilities of forensic science, the conceptual knowledge underpinning investigative practice remains underexamined. The ability of practitioners to interpret and apply core forensic principles influences not only the quality of evidence collected but also the reliability of investigative conclusions.

Existing scholarship has largely focused on the technical dimensions of forensic investigation, including laboratory procedures, DNA analysis, and crime scene processing. By contrast, far less attention has been paid to the conceptual competence of frontline practitioners. Foundational forensic concepts, such as the distinction between criminal and

forensic investigation, the logic of identification and individualisation, and the application of Locard's Exchange Principle, form the intellectual basis of forensic reasoning. Yet there is limited empirical research examining how practitioners understand and operationalise these principles. Much of the literature implicitly assumes conceptual clarity, despite growing evidence that misunderstandings may compromise investigative reasoning, the interpretation of evidence, and judicial outcomes. This gap is particularly significant in homicide investigations, which require advanced analytical reasoning, situational judgement, and the accurate application of forensic concepts in complex, dynamic conditions. Conceptual limitations may affect how practitioners recognise, interpret, and contextualise evidence. For instance, an incomplete understanding of Locard's Exchange Principle may lead to misinterpretation of transfer mechanisms or contamination risks, while confusion between class and individual characteristics may result in inaccurate inferences about evidentiary value and suspect involvement. Similarly, conflating the objectives of criminal and forensic investigations may disrupt investigative sequencing and decision-making.

Against this backdrop, the aim of this study is to examine how crime scene practitioners conceptualise and interpret core forensic principles within the context of homicide investigations. The study explores practitioner understandings of criminal investigation, forensic investigation, Locard's Exchange Principle, identification, and individualisation. The article argues that conceptual competence is not merely a theoretical concern but a critical determinant of investigative reliability. Where conceptual understanding is fragmented or underdeveloped, forensic reasoning, evidence interpretation, and the overall investigative trajectory may be significantly compromised.

The next section outlines the theoretical framework guiding the study, followed by a focused review of relevant literature. The methodology section details the qualitative interpretivist approach adopted to examine practitioner perspectives. The findings present practitioner interpretations of the five core forensic concepts, which are then analysed in relation to existing literature and forensic theory. Finally, the article concludes by discussing the implications of conceptual competence for homicide investigations and offering recommendations for strengthening forensic training, practice, and organisational policy.

Theoretical Framework

This study is guided by three complementary theoretical foundations: Locard's Exchange Principle, Systems Theory, and the Interpretivist Knowledge Framework. These perspectives provide a multidimensional lens for examining how practitioners conceptualise and apply core forensic principles in homicide investigations. They enable analysis at three interconnected levels: the scientific basis for interpreting evidence (Locard's Principle), the organisational context that shapes practice (Systems Theory), and the subjective processes by which practitioners construct meaning (Interpretivism). Together, these frameworks offer a comprehensive approach to understanding conceptual competence in forensic investigation.

Locard's Exchange Principle

Locard's Exchange Principle, a foundational concept in forensic science, holds that every contact results in a transfer of material (Barbaro, 2018:13; Lee & Pagliaro, 2013:2). In homicide investigations, this principle underpins the recovery and interpretation of physical evidence, including biological material, trace DNA, fibres, residues, and impressions. Beyond its role as a scientific rule, Locard's Principle carries significant interpretive implications for forensic reasoning. The presence of evidence does not inherently indicate direct or exclusive involvement; rather, it requires careful interpretation within a broader evidentiary context (Gardner & Krouskup, 2019:32). Conceptual competence in this regard involves understanding the mechanisms, conditions, and limitations of transfer. This includes distinguishing between primary, secondary, and tertiary transfer, and evaluating factors such as persistence, distribution, and environmental influence (Meakin, Kokshoorn, van Oorschot, & Szkuta, 2020:1404). Accordingly, the application of Locard's Principle extends beyond the identification of trace evidence to encompass the interpretation of its meaning within the dynamics of the crime scene. This involves assessing contamination pathways, reconstructing movement patterns, and analysing the spatial distribution of evidence (Dutelle, 2022:48). Locard's Principle therefore functions not only as a scientific foundation but also as a framework for evidentiary interpretation and inferential reasoning. This study employs Locard's Exchange Principle to examine how practitioners understand and apply concepts of transfer and trace evidence, and how these interpretations influence the reconstruction of events in homicide investigations.

Systems Theory

Systems Theory conceptualises forensic investigation as a complex, interdependent system comprising multiple interacting components, including practitioners, training structures, protocols, resources, communication processes, and organisational culture (von Bertalanffy, 1968:55-60; Checkland, 1999:7-15). Within this framework, practitioner

knowledge is not developed in isolation but is shaped and constrained by the institutional environment in which forensic work is conducted. From a conceptual competence perspective, Systems Theory highlights how organisational structures and practices influence the development and application of forensic knowledge (Checkland, 1999:17-20). It explains the persistence of conceptual misunderstandings due to entrenched organisational norms, the role of training systems in shaping practitioners' understanding, and the impact of resource constraints on investigative decision-making. Furthermore, inconsistencies in practice may arise from misaligned procedures, fragmented communication, or gaps between policy and implementation. Systems Theory therefore underscores that conceptual competence is not solely an individual attribute but a systemic outcome of organisational design, training models, and institutional processes (von Bertalanffy, 1968:45-47). Consequently, individual knowledge limitations may extend beyond personal understanding, affecting the broader forensic process and influencing evidence handling, interpretation, and the overall quality of investigative outcomes. In this study, Systems Theory provides a lens for examining how structural and organisational factors shape practitioner interpretations of forensic principles in homicide investigations.

Interpretivist Knowledge Framework

The interpretivist knowledge framework posits that knowledge is socially constructed through experience, interaction, and contextual engagement (Berger & Luckmann, 1966:1-7; Schutz, 1967:67-75). In the context of homicide investigations, practitioners develop and apply forensic understanding through a process of meaning-making grounded in their everyday operational realities. Practitioner interpretations of forensic principles are therefore shaped by a range of experiential and contextual influences, including prior investigative experience, informal learning, peer interaction, organisational culture, and familiarity with specific case contexts. Rather than relying primarily on formal theoretical instruction, practitioners often construct knowledge through repeated exposure to investigative scenarios and practical problem-solving (Schwandt, 2000:197-202). Conceptual competence, from this perspective, is not a fixed or purely technical attribute but a dynamic and context-dependent process (Schutz, 1967:72-75). It reflects how practitioners interpret key forensic concepts, assign meaning to principles, such as Locard's Exchange Principle, and apply these interpretations in investigative practice. This framework also accounts for variability in understanding, as different practitioners may interpret the same forensic concepts in divergent ways based on their experiences and contexts. In this study, the interpretivist framework supports an exploration of how practitioners construct and apply forensic knowledge, enabling analysis of how conceptual assumptions shape investigative reasoning and decision-making in homicide investigations.

Theoretical Integration

These theoretical perspectives provide a coherent framework for analysing conceptual competence in forensic investigation. Locard's Exchange Principle establishes the scientific basis for forensic evidence and its interpretation; Systems Theory highlights the organisational and structural influences on practitioners' knowledge; and the interpretivist framework explains how practitioners construct meaning through experience and social context. This integrated framework positions conceptual competence as both a cognitive and a systemic phenomenon. It captures the interplay among scientific principles, organisational environments, and practitioner interpretation, thereby providing a comprehensive basis for analysing how forensic knowledge is internalised, interpreted, and applied in practice. Through this lens, the study examines how conceptual limitations emerge and how they affect the reliability and effectiveness of homicide investigations.

Literature Review

The literature identifies several core processes that influence the integrity of DNA evidence at crime scenes, including conceptualisation, crime scene management, contamination control, examination, access regulation, and preservation. Central to these processes is conceptual competence, which underpins the quality, accuracy, and reliability of forensic decision-making in homicide investigations. Although forensic scholarship provides extensive theoretical and methodological guidance on criminal investigation, forensic investigation, Locard's Exchange Principle, and the concepts of identification and individualisation, the dominant focus has remained on technical procedures and scientific advancements. Comparatively limited attention has been given to how frontline practitioners understand, interpret, and apply these foundational forensic concepts in practice. This imbalance reflects an implicit assumption within forensic and policing scholarship that practitioners possess sufficient conceptual knowledge to engage effectively with forensic principles. However, this assumption remains largely untested in empirical research. Consequently, there is limited understanding of whether practitioner knowledge aligns with established forensic theory and how conceptual gaps may influence investigative reasoning, evidence interpretation, and decision-making in real-world contexts.

Criminal Investigation as a Scientific and Logical Process

Criminal investigation is widely defined as a systematic, logical, and evidence-based process aimed at uncovering the truth about a criminal event (Becker, 2009:14; Brandl, 2020:21). Whereas early investigative practices relied heavily on intuition and experience, modern approaches are grounded in scientific reasoning, structured decision-making, and methodical evaluation of evidence (Gehl & Plecas, 2019:16). According to Lee and Pagliaro (2013:2), criminal investigation involves reconstructing events by integrating physical evidence, witness accounts, and contextual information, requiring investigators to apply analytical thinking and problem-solving strategies. This process requires hypothesis formulation, testing competing interpretations, and adherence to evidence-driven investigative pathways (Dutelle, 2022:48), rather than reliance on intuition alone. Contemporary scholarship further highlights the role of investigative logic, including the systematic evaluation of alternative explanations, the elimination of unlikely scenarios, and the use of evidence to support or challenge emerging conclusions (Brandl, 2020:21). In homicide investigations, such logical structuring is critical, as errors in reasoning or interpretation may lead to wrongful convictions, investigative bias, and misallocation of resources. Despite its scientific orientation, criminal investigation remains an inherently interpretive activity, shaped by practitioner knowledge, training, and conceptual understanding. Conceptual competence, therefore, emerges as a critical resource, influencing investigative reasoning and decision-making from the earliest stages of the investigative process, prior to formal forensic analysis.

Forensic Investigation and Its Core Objectives

Forensic investigation is conceptually distinct from criminal investigation, although the two processes are closely interconnected. Whereas criminal investigation focuses on reconstructing events and identifying offenders, forensic investigation emphasises the scientific recovery, preservation, and interpretation of physical evidence (Lee & Pagliaro, 2013:2; Dutelle, 2022:48). It applies scientific methods to determine what occurred, how it occurred, and the evidentiary links among individuals, objects, and events. A central objective of forensic investigation is the accurate recognition, analysis, and interpretation of physical evidence (Barbaro, 2018:13). This includes understanding the nature and properties of biological, trace, and physical materials, as well as the environmental and behavioural factors that influence their transfer, persistence, and distribution at the crime scene. In addition, forensic investigation requires adherence to principles of objectivity, standardisation, and methodological rigour to ensure that evidence is preserved and interpreted without bias (Dutelle, 2022:48; Barbaro, 2018:13). The literature consistently emphasises that forensic investigation must be both scientifically grounded and procedurally sound. This requires practitioners to possess not only technical skills but also a conceptual understanding of the types of evidence, contamination risks, and recovery protocols. Without such conceptual clarity, there is a risk that forensic tasks may be conflated with general investigative procedures, leading to the misinterpretation of evidence and reduced investigative reliability.

Locard's Exchange Principle in Modern Forensic Practice

Locard's Exchange Principle is one of the fundamental theoretical foundations of forensic science. The principle asserts that every contact results in a transfer of material, indicating that interactions between individuals, objects, and environments inevitably leave trace evidence (Lee & Pagliaro, 2013:2). In contemporary forensic science, this concept extends beyond visible traces to include biological material, particularly DNA, which can be transferred through both direct contact and indirect mechanisms involving intermediaries such as tools, clothing, or surfaces. Recent scholarship has deepened our understanding of transfer dynamics by distinguishing between primary, secondary, and tertiary transfer. These distinctions demonstrate that DNA can be transferred without direct physical contact between individuals, thereby complicating the interpretation of evidentiary presence (Sessa, Pomara, Esposito, Grassi, Cocimano, & Salerno, 2023:2153; Meakin et al., 2020:1404). This has significant implications for homicide investigations when the presence of DNA evidence cannot be assumed to indicate direct involvement. Instead, forensic interpretation requires careful consideration of transfer mechanisms, contextual factors, and the conditions under which evidence may have been deposited. Misinterpretation of transfer pathways poses a substantial risk to investigative accuracy. Incorrect assumptions regarding the origin or relevance of trace evidence may lead to erroneous conclusions about suspect presence or involvement (van Oorschot, Szkuta, Meakin, Kokshoorn, & Goray, 2019:150-152). In addition, the literature emphasises the critical relationship between Locard's Principle and contamination control. Biological material is inherently transferable and highly susceptible to redistribution, particularly in poorly managed crime scenes. Improper handling, inadequate scene control, or procedural lapses may unintentionally introduce or relocate DNA, thereby altering the evidentiary landscape (Dutelle, 2022:48; Barbaro, 2018:41). Accordingly, effective application of Locard's Exchange Principle requires more than awareness of transfer; it demands conceptual understanding of the mechanisms, limitations, and interpretive significance of trace evidence. Practitioners must be able to evaluate persistence, distribution, and contamination pathways within the broader context

of the crime scene. Locard's Principle, therefore, serves not only as a scientific foundation but also as a critical framework for forensic reasoning, interpretation of evidence, and contamination prevention in homicide investigations.

Identification in Forensic Science

Identification in forensic science refers to the process of determining the class characteristics of evidence attributes that enable investigators to classify an item within a broader category or group (Becker, 2009:14; Lee & Pagliaro, 2013:2; Becker, 2009:14). Class characteristics are features shared by multiple individuals or objects, such as blood type, footwear size and pattern, fibre type or colour, and general toolmark features. These characteristics allow investigators to group evidence but do not link it to a single source. The literature consistently emphasises that identification constitutes a critical preliminary stage in forensic analysis (Lee & Pagliaro, 2013:2). It enables investigators to establish the nature of the material, assess its potential relevance to the investigation, and determine the appropriate analytical pathways. Through identification, practitioners decide whether evidence warrants further examination using specialised techniques such as DNA profiling, toxicological analysis, or ballistic comparison (Barbaro, 2018:36).

Identification is conceptually distinct from individualisation. This distinction is fundamental to the correct interpretation of forensic evidence. Whereas identification classifies evidence within a group, individualisation seeks to associate evidence with a specific, unique source. Failure to distinguish between these processes may lead to overestimating the evidentiary value and to inaccurate forensic conclusions. For instance, identifying the class characteristics of a shoe print does not establish that it originated from a particular individual. The literature therefore emphasises the importance of maintaining this conceptual boundary to preserve scientific objectivity and minimise investigative bias (Dutelle, 2022:48; Barbaro, 2018:13; Gardner & Krouskup, 2019:28). A clear understanding of identification as a classificatory process is essential to ensure that evidence is interpreted within its appropriate evidentiary limits and that subsequent analytical stages are applied correctly.

Individualisation in Forensic Science

Individualisation refers to the process of determining whether evidence can be attributed to a single, unique source, to the exclusion of all others (Lee & Pagliaro, 2013:2; Gardner & Krouskup, 2019:28). It represents the highest level of forensic inference and is most clearly demonstrated in DNA profiling, as modern techniques allow biological material to be associated with a specific individual with a high degree of statistical certainty. The literature emphasises that individualisation is a rigorous and methodologically demanding process. It requires the systematic comparison of class characteristics, the identification of unique or individualising features, and the exclusion of alternative sources through scientific and probabilistic reasoning. This process is underpinned by strict adherence to evidentiary integrity, ensuring that conclusions are based on reliable and verifiable analytical procedures. Individualisation constitutes a high evidentiary threshold and is not universally applicable to all forms of forensic evidence. As highlighted in the literature, many evidence types such as fibres, footwear impressions, toolmarks, and certain forms of trace DNA cannot be conclusively individualised and remain limited to classification at the identification level (Becker, 2009:14; Lee & Pagliaro, 2013:2; Barbaro, 2018:13). Failure to recognise these limitations may result in the overstatement of forensic conclusions and the misinterpretation of evidentiary strength.

The distinction between identification and individualisation is therefore critical to maintaining scientific accuracy and objectivity in forensic investigation. Conceptual confusion between these processes may lead practitioners to incorrectly infer that evidence establishes a unique source when it merely indicates group-level similarity. Such misinterpretations carry significant risks in homicide investigations, where evidentiary conclusions directly influence investigative direction and judicial outcomes. Despite the clarity with which these principles are articulated in the literature, forensic scholarship remains largely normative, focusing on how forensic concepts should be applied rather than examining how they are understood and interpreted in practice. This creates a disconnect between theoretical knowledge and operational realities, particularly within complex investigative environments such as homicide investigations.

Synthesis of Literature and Research Gap

The literature demonstrates that forensic reasoning is grounded in a set of interconnected conceptual foundations. Criminal investigation, forensic investigation, Locard's Exchange Principle, identification, and individualisation form the intellectual framework that guides the recognition, interpretation, and evaluation of evidence. These principles ensure scientific rigour, investigative reliability, and legally defensible conclusions. But the literature offers limited empirical insight into how frontline practitioners understand these foundational concepts. Existing research has

predominantly focused on technical proficiency, laboratory processes, and investigative outcomes, while largely overlooking the cognitive and conceptual dimensions that shape practitioner reasoning at a crime scene. This omission is significant, as conceptual misunderstandings may affect how evidence is recognised, interpreted, and applied in investigative contexts. Accordingly, a critical gap exists between established forensic theory and practitioner understanding in operational environments. Addressing this gap is essential for advancing both forensic scholarship and investigative practice. This study contributes to the literature by empirically examining how practitioners conceptualise core forensic principles in homicide investigations, thereby providing insight into the relationship between forensic theory and investigative decision-making.

Methodology

This study adopted an interpretivist qualitative approach to explore how crime scene practitioners conceptualise and interpret core forensic principles in homicide investigations. The interpretivist paradigm is appropriate for this study as it assumes that knowledge is socially constructed and that individuals develop meaning through experience, interaction, and professional practice (Berger & Luckmann, 1966:1–7; Schutz, 1967:67–75). This approach enabled an in-depth examination of how practitioners understand and apply forensic concepts within real-world investigative contexts. A qualitative, exploratory, and descriptive research design was employed. Qualitative research is well suited to exploring subjective experiences and meanings, particularly in contexts where empirical knowledge is limited (Creswell & Poth, 2018:41–43). The exploratory dimension addressed the limited empirical research on practitioners' conceptual competence in forensic science, while the descriptive component facilitated detailed documentation of practitioner interpretations of key forensic principles. This design allowed for rich, contextually grounded insights into the cognitive and conceptual processes underpinning investigative practice. Data were collected through semi-structured, in-depth interviews with 36 participants, including detectives, first responding officers, crime scene investigators, and forensic support personnel. Semi-structured interviews are widely recognised as effective for exploring participants' perspectives while allowing flexibility in probing complex concepts (Kvale & Brinkmann, 2009:131). Participants were selected through purposive sampling to ensure that individuals with experience in homicide and crime scene investigations were included (Patton, 2015:264). This approach was appropriate for capturing informed perspectives relevant to the study's objectives. An interview guide consisting of open-ended questions was used to explore participants' understanding of criminal investigation, forensic investigation, Locard's Exchange Principle, identification, and individualisation. Interviews were conducted face-to-face in private settings to ensure confidentiality and encourage open engagement. With participants' consent, interviews were audio-recorded and transcribed verbatim. Field notes were also maintained to capture contextual observations and support interpretive analysis. Data analysis followed Braun and Clarke's (2006:87–93) six-phase thematic analysis framework, including familiarisation, initial coding, theme development, theme review, theme definition, and reporting. An inductive approach was adopted, allowing themes to emerge from participant narratives rather than being imposed a priori. Coding focused on identifying patterns related to conceptual understanding, misconceptions, interpretive reasoning, and experiential influences. Themes were iteratively refined through constant comparison to ensure consistency and analytical depth. To enhance the study's trustworthiness, several strategies were employed. Credibility was strengthened through prolonged engagement with the data and the use of verbatim quotations to support findings (Lincoln & Guba, 1985:301–316). Dependability and confirmability were enhanced through iterative coding, peer debriefing, and reflexive journaling. These measures ensured that the analysis remained transparent, consistent, and grounded in the data. Ethical approval was obtained prior to data collection. Participants were informed of the study's purpose, voluntary nature, and their right to withdraw without penalty. Written informed consent was obtained, and confidentiality was maintained through anonymisation of transcripts and secure data storage. Ethical principles of respect, beneficence, and non-maleficence guided all stages of the research process (Orb, Eisenhauer, & Wynaden, 2001:96–97).

Results and Discussion

This section presents the study's findings in relation to five core forensic concepts explored with participants: criminal investigation, forensic investigation, Locard's Exchange Principle, identification, and individualisation. The findings reflect participants' conceptual interpretations, supported by verbatim quotations, and are situated within the interpretivist framework underpinning this inquiry.

Criminal Investigation as a Scientific and Logical Process

Practitioners predominantly conceptualised criminal investigation as a task-driven process centred on identifying suspects and gathering information. Their responses emphasised operational actions rather than analytical reasoning or the structured reconstruction of events. This is reflected in participants' statements: "Finding out who committed

the crime" (Participant A3); "Following leads until you get the suspect" (Participant C1). Only a limited number of participants demonstrated elements of analytical reasoning: "You must look at everything and see how the story fits together" (Participant A6). These findings indicate a constrained conceptualisation of criminal investigation, in which procedural execution takes precedence over scientific reasoning. The absence of references to hypothesis testing, the evaluation of competing explanations, and evidence-based reconstruction suggests that investigation is largely understood as a linear process rather than a dynamic analytical exercise. This procedural orientation has important implications for investigative practice. When a criminal investigation is framed primarily as suspect identification, there is an increased risk of premature closure, confirmation bias, and insufficient consideration of alternative scenarios increases. Such limitations may undermine the depth and objectivity of investigative reasoning, particularly in complex cases such as homicide, where systematic and critical analysis is essential.

The findings further reveal that practitioners adopt a predominantly suspect-focused and task-oriented understanding of criminal investigation. Such a perspective aligns with traditional policing models that prioritise offender apprehension (Becker, 2009; Brandl, 2020), and diverges from contemporary scholarship, which conceptualises criminal investigation as a scientific, hypothesis-driven process requiring logical reasoning and a systematic evaluation of competing explanations (Gehl & Plecas, 2019; Lee & Pagliaro, 2013). The limited reference to investigative logic, probabilistic reasoning, and structured reconstruction suggests a reliance on experiential heuristics rather than formal analytical frameworks. From an interpretivist standpoint, this implies that practitioner meaning-making is shaped predominantly by routine operational experiences rather than formal theoretical or methodological training.

Forensic Investigation and Its Core Objectives

Participants largely equated forensic investigation with crime scene processing and evidence collection, reflecting a narrow, procedural view of its purpose. This perspective is evident in the following responses: "Collecting evidence" (Participant B2); "The science part where you take things to the lab" (Participant A1). These interpretations emphasise tangible, task-oriented actions while overlooking the interpretive and analytical dimensions central to forensic science. Notably absent were references to reconstruction, sequence analysis, or the evaluation of evidentiary significance. This suggests limited engagement with the underlying scientific logic of forensic investigation. Rather than being understood as a process of interpreting evidence within a contextual and inferential framework, forensic work is conceptualised primarily as the extraction and transfer of physical material. This conceptual limitation has significant implications. When forensic investigation is reduced to evidence collection, practitioners fail to recognise the inferential value of evidence, treat items in isolation, and overlook the broader contextual relationships that inform forensic conclusions. Such limitations weaken the integration between evidence recovery and investigative reasoning, potentially undermining the overall quality of forensic interpretation.

The findings further indicate that forensic investigation is largely reduced to evidence collection and laboratory submission, which is characteristic of a procedural view of forensic practice. Although participants acknowledged the role of forensic specialists and laboratory analysis, they did not engage with key forensic objectives, including reconstruction, sequence analysis, transfer interpretation, or the evaluation of evidentiary significance (Dutelle, 2022:48; Barbaro, 2018:13; Gardner & Krouskup, 2019:28). This limitation is critical, as it suggests that evidence is treated as isolated material rather than as part of a broader interpretive framework. Consequently, practitioners may misinterpret forensic findings, fail to contextualise evidence within scene dynamics, and overlook the inferential processes underpinning forensic reasoning. From a theoretical perspective, Systems Theory helps explain this pattern by showing how organisational structures and training models may prioritise procedural competence while neglecting conceptual and analytical development.

Locard's Exchange Principle in Modern Forensic Practice

Because participants' knowledge of Locard's Exchange Principle was largely implicit, it lacked conceptual depth. Although several participants articulated intuitive notions of trace transfer, none demonstrated a clear understanding of the principle as a foundational framework for forensic reasoning. This shortcoming is reflected in the following statement: "When someone moves around, they leave something behind or pick something up" (Participant A4). Although such responses indicate partial awareness of transfer dynamics, they remain descriptive rather than theoretical. Notably absent were references to key forensic distinctions such as primary, secondary, or tertiary transfer, as well as considerations of persistence, distribution, and the contextual interpretation of trace evidence. This suggests that Locard's Principle is understood in a simplified, intuitive manner rather than as a structured scientific concept that underpins the interpretation of evidence.

Furthermore, transfer was frequently framed in terms of contamination risk rather than as a fundamental mechanism of forensic inference. Such a limited perspective reduces the principle to a precautionary notion and fails to recognise its broader analytical significance in reconstructing events and interpreting evidentiary meaning. The implications of this conceptual limitation are substantial. Without a clear understanding of transfer mechanisms, practitioners may misinterpret the presence, movement, and significance of trace evidence. This may result in incorrect assumptions about suspect involvement, underestimation of contamination pathways, and flawed reconstruction of events. Given the central role of trace and DNA evidence in homicide investigations, such limitations pose a significant risk to investigative accuracy. This finding highlights a critical gap in practitioners' conceptual foundations. Despite some intuitive awareness, the absence of engagement with Locard's Principle as a scientific framework suggests that forensic reasoning is not fully integrated into practice. From a theoretical perspective, this limitation can be understood as a systemic issue, reflecting shortcomings in forensic training and organisational knowledge transmission rather than solely individual practitioner deficiencies.

Identification in Forensic Science

A pervasive conceptual conflation emerged in practitioners' understanding of identification. Rather than recognising identification as the classification of evidence based on shared (class) characteristics, most participants interpreted it as the process of determining a suspect's identity. This is reflected in the following response: "Identifying who did it" (Participant B6). Only a small number of participants demonstrated a partial understanding of the concept. One participant noted that "identification is seeing what type of evidence it is" (Participant A2). These findings reveal a misunderstanding of the fundamental role of identification within forensic science. The absence of reference to class characteristics indicates that practitioners may not fully recognise identification as an analytical stage that precedes and informs further forensic evaluation. Instead, identification is frequently collapsed into suspect attribution, thereby bypassing its preliminary and classificatory function. This conceptual conflation has significant implications for investigative reasoning. When identification is equated with suspect attribution, practitioners may overstate the evidentiary value of initial findings and prematurely narrow their focus to specific individuals. Such misinterpretations undermine the logical sequencing of forensic analysis and increase susceptibility to cognitive and confirmation bias. The findings align with existing literature highlighting conceptual weaknesses in practitioners' understanding of identification and individualisation. Identification is defined as the classification of evidence based on shared characteristics, rather than the determination of a specific source (Becker, 2009:14; Lee & Pagliaro, 2013:2). The observed misunderstanding therefore reflects a fundamental misalignment with the forensic hierarchy of evidence and suggests limited awareness of the evidentiary value and limitations of class characteristics. When class characteristics are misinterpreted as individualising features, the risk of overstating their evidentiary significance and prematurely narrowing the investigative focus is high. This reinforces the need for stronger conceptual training to ensure that practitioners apply forensic principles in a logically consistent and scientifically grounded manner.

Individualisation in Forensic Science

Individualisation emerged as the least understood forensic concept, with widespread confusion evident among participants. Most were unable to articulate its meaning or distinguish it from identification, frequently interpreting it as the process of identifying a specific individual. This misconception is reflected in the following responses: "It means identifying the individual" (Participant A3); "Finding whom the DNA belongs to" (Participant B1). Even where partial understanding was evident, it lacked engagement with the underlying scientific principles: "Matching something exactly to one person" (Participant C5). Participants made no reference to the key components of individualisation, including the comparison of class and individual characteristics, the systematic exclusion of alternative sources, and the application of statistical or probabilistic reasoning. This indicates a highly simplified and conceptually incomplete understanding of individualisation as a forensic process.

The implications of this limitation are significant. Given the central role of individualisation in linking evidence to specific sources, a lack of conceptual clarity may lead practitioners to overestimate the certainty of forensic findings, misinterpret DNA or trace evidence, and communicate inaccurate or overstated conclusions in investigative and legal contexts. This highlights a critical gap in understanding how forensic evidence is evaluated and its evidentiary limits. These findings align with the existing literature, which conceptualises individualisation as a scientifically grounded, probabilistic process that requires comparing characteristics, excluding alternative explanations, and applying statistical reasoning (Lee & Pagliaro, 2013; Gardner & Krouskup, 2019). The absence of these elements in practitioners' responses suggests a fundamental misalignment with the evidentiary hierarchy that underpins forensic interpretation. From a systems perspective, this conceptual weakness reflects broader organisational and training limitations, stemming from an emphasis on procedural competence rather than on the development of analytical and

theoretical understanding. Consequently, practitioners may lack the conceptual tools to interpret forensic evidence within a scientifically coherent framework.

Synthesis of Findings: Conceptual Gaps in Forensic Understanding

Across all themes, a consistent pattern emerges: practitioners demonstrate basic but fragmented knowledge, characterised by procedural familiarity without corresponding conceptual clarity. Their understanding appears to be shaped primarily by operational experience, informal learning, and organisational practice, rather than by formal engagement with forensic theory. The most pronounced conceptual gaps were in Locard's Exchange Principle and the distinction between identification and individualisation. These findings indicate that conceptual competence is uneven and underdeveloped, limiting practitioners' ability to interpret forensic evidence within a scientifically grounded framework.

The results reveal a broader theory-practice gap in forensic investigation. Forensic science, as a well-established conceptual foundation, is not consistently internalised or applied by frontline practitioners. From an interpretivist perspective, this gap can be a consequence of experiential learning, in which meaning is constructed through practice rather than through formal theoretical engagement. Systems Theory further explains that institutional environments, organisational priorities, and training structures shape practitioner knowledge, often reinforcing procedural approaches at the expense of conceptual development. Across all domains, practitioner knowledge is practical and experience-based but conceptually fragmented. Foundational forensic principles, particularly Locard's Exchange Principle and the distinction between identification and individualisation, are inconsistently understood or applied. These are not merely individual deficiencies; they can be attributed to systemic issues within training, organisational culture, and professional development. These findings support the central argument of this study: conceptual competence is an underdeveloped yet critically important dimension of homicide investigation practice. Effective forensic investigation depends not only on technical skill and procedural compliance but also on the ability to interpret and apply forensic principles within a coherent scientific framework. Without this conceptual foundation, practitioners risk misinterpreting evidence, misunderstanding transfer dynamics, and overstating evidentiary conclusions, thereby undermining the scientific integrity of forensic investigations. Strengthening conceptual competence is therefore essential to improving investigative reasoning, enhancing the reliability of forensic evidence, and ensuring accurate, defensible outcomes within the criminal justice system.

Limitations and Future Research

This study provides important insights into practitioners' conceptual competence in homicide investigations; however, several limitations should be acknowledged. First, the findings are based on self-reported data obtained through interviews. Although this approach offers valuable insight into practitioner perceptions and interpretations, it may not fully capture how forensic principles are applied in practice. Participants' responses may also be influenced by recall bias or social desirability, potentially affecting the accuracy of reported understanding. Second, the study is context-specific, focusing on a particular organisational and national setting. Therefore, its findings may not be fully generalisable to other jurisdictions with different training systems, forensic infrastructures, and policing cultures. Although the study provides valuable insight into frontline practice, variations across regions and institutional contexts may produce different patterns of conceptual understanding. Third, while the sample included a range of practitioner roles, the study did not explicitly compare conceptual competence across ranks, levels of experience, or specialised units. As a result, differences in knowledge associated with professional background or training exposure were not systematically examined.

Future research should extend this work by incorporating observational and mixed-method approaches to examine how conceptual understanding is enacted in real investigative settings. Comparative studies across jurisdictions, agencies, and training environments would provide deeper insight into how organisational factors shape conceptual competence. Further research should also explore differences across practitioner categories, including rank, experience, and specialisation, to better understand how conceptual knowledge develops within policing systems. In addition, intervention-based studies assessing the impact of theory-informed training programmes, scenario-based learning, and interdisciplinary collaboration with forensic scientists would be valuable for identifying effective strategies to strengthen conceptual competence in practice. In light of these limitations, the following recommendations are proposed to strengthen conceptual competence in forensic practice.

Recommendations

The findings of this study reveal significant gaps in practitioners' conceptual understanding of core forensic principles, particularly regarding the distinction between criminal and forensic investigation, the application of Locard's

Exchange Principle, and the differentiation between identification and individualisation. Addressing these limitations is essential for strengthening forensic reasoning, improving the interpretation of evidence, and enhancing the overall integrity of homicide investigations.

Conceptually grounded forensic training programmes that extend beyond procedural instruction must be developed. Current training approaches should be restructured to explicitly incorporate foundational forensic theory, with particular emphasis on the scientific logic underpinning criminal investigation, the interpretive objectives of forensic investigation, the mechanisms of trace transfer as articulated by Locard's Exchange Principle, and the evidentiary hierarchy distinguishing identification from individualisation. Embedding these concepts within training will enhance practitioners' ability to apply forensic principles within a coherent analytical framework.

Forensic theory should be systematically integrated into investigative curricula across all levels of practitioner development. Formal education and training programmes for detectives, crime scene investigators, and first responders should balance technical skill acquisition with conceptual understanding. Both pre-service and in-service training must prioritise conceptual competence to ensure that practitioners not only execute procedures but also understand the reasoning that informs their actions.

Conceptual learning can be further strengthened through scenario-based and simulation-driven training. Applied training environments can demonstrate how conceptual misunderstandings translate into investigative errors, including the misinterpretation of transfer mechanisms, misclassification of evidence, and conflation of identification with individualisation. Such experiential approaches are critical for bridging the gap between theoretical knowledge and practical application.

Greater emphasis is required on interdisciplinary collaboration between frontline practitioners and forensic scientists. Structured engagement through joint training initiatives, case debriefings, and collaborative workshops can enhance shared understanding of forensic principles and improve the translation of scientific findings into investigative decision-making. Strengthening this interaction is essential for improving both conceptual clarity and applied forensic reasoning.

Policing organisations should reinforce institutional support for conceptual competence by promoting a culture of evidence-based reasoning and reflective practice. Organisational policies, supervisory practices, and standard operating procedures should prioritise scientifically grounded decision-making and reduce over-reliance on experiential heuristics. Fostering such an environment will contribute to more consistent, transparent, and defensible investigative outcomes.

Continuous professional development should be institutionalised to ensure that practitioners maintain their current conceptual knowledge within an evolving forensic landscape. This may include regular refresher training, specialised workshops, and access to emerging forensic research. Sustained professional learning is essential for reinforcing conceptual competence and supporting the ongoing development of forensic expertise.

These recommendations reinforce the central argument of this study: conceptual competence is a foundational requirement for forensic effectiveness. Strengthening practitioner understanding of core forensic principles will enhance investigative reliability, improve the interpretation of evidence, and contribute to more scientifically robust and defensible homicide investigations.

Conclusion

This study examined how crime scene practitioners interpret and apply core forensic principles in homicide investigations, focusing on their understanding of criminal and forensic investigation, Locard's Exchange Principle, identification, and individualisation. The findings demonstrate that while practitioners possess practical experience and operational knowledge, their conceptual understanding of these principles is fragmented, superficial, and often misaligned with established forensic science literature. This reveals a significant gap between investigative practice and theoretical comprehension. The study reinforces its central argument that conceptual competence is fundamental to the scientific and interpretive integrity of homicide investigations. Misunderstandings of foundational forensic principles, particularly Locard's Exchange Principle and the distinction between identification and individualisation, extend beyond procedural errors to affect investigative reasoning, evidence interpretation, and decision-making. Conceptual deficiencies may compromise the reliability of forensic conclusions in the earliest stages of the investigative process. Interpreted through the combined lens of Locard's Exchange Principle, Systems Theory, and the Interpretivist Knowledge Framework, these findings demonstrate that conceptual gaps are not merely individual limitations but are shaped by broader organisational and training contexts. Practitioner understanding is formed largely

through experiential learning within institutional environments that prioritise procedural performance over theoretical grounding. This highlights the systemic nature of conceptual competence and its influence on how evidence is recognised, interpreted, and applied in practice. This study contributes to the field by foregrounding practitioner interpretation as a critical point of analysis within the forensic process. While forensic scholarship focuses on laboratory science, these findings show that conceptual errors originate at the earliest stage of evidence interaction. Addressing this gap is therefore essential for strengthening the overall integrity of forensic investigation. Ultimately, the study demonstrates that effective homicide investigation depends not only on technical proficiency and forensic technology but also on the conceptual frameworks that guide practitioner reasoning. Strengthening conceptual competence through theory-informed training, interdisciplinary collaboration, and organisational support will enhance investigative accuracy, improve the interpretation of evidence, and contribute to more scientifically robust and defensible forensic practice.

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