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Research on the Application of Virtual Simulation Technology in Document Identification Experiment Teaching

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ABSTRACT Forensic identification is an interdisciplinary field combining science and technology with legal proceedings. Experiment teaching plays a crucial role in cultivating forensic talent. However, traditional forensic identification experiment teaching is constrained by factors such as venue limitations, high equipment costs, safety risks, and lack of scientific evaluation, making it difficult to meet the current demands for high-quality talent development in forensic identification. Virtual simulation technology, characterized by realism, immersion, and interactivity, overcomes temporal and spatial constraints, reduces experimental costs, ensures safety, and enables scientific evaluation. Taking document examination—one of the most common practices in forensic identification—as an example, this paper analyzes the existing issues in experiment teaching and explores the significance and application paths of introducing virtual simulation technology into document examination experiment teaching.

KEY WORDS Document Examination, Forensic Identification, Virtual Simulation, Experiment Teaching

1. INTRODUCTION

Forensic identification refers to the activity where experts apply scientific technology or specialized knowledge to examine and judge specialized issues in legal proceedings, providing forensic opinions. Document examination is one of the most common categories of forensic identification in litigation. It involves applying the principles and techniques of document examination science to analyze handwriting, seals, prints, methods of document creation, tools used, and the formation time of documents.

With the increasing emphasis on democratization and scientific methods in modern litigation, document examination has become increasingly significant in legal proceedings. Cases requiring document examination have been steadily rising, accounting for a substantial proportion of all three major types of litigation. Regardless of whether law students pursue careers as judges, prosecutors, lawyers, or corporate legal officers, they will inevitably encounter document examination.

In recent years, the ongoing digital transformation in judicial practice has profoundly influenced legal operations, research, and education. Training forensic identification talent must align with this digital trend, fostering innovative approaches to cultivating exceptional legal professionals in the new era. The construction of virtual simulation

experiment projects in forensic identification is a key strategy for achieving this goal, enabling the cultivation of application-oriented and multidisciplinary talent.

Amid the rise of the internet, interactive and shared online teaching platforms and virtual simulation teaching methods have flourished. However, there remains a lack of effective online teaching projects specifically designed for forensic identification education. Reforming the teaching model under the "Internet+" framework necessitates establishing comprehensive online resources and virtual simulation projects tailored to forensic identification. Education in this field must incorporate both traditional practical teaching and modern, information-based teaching methods. To cultivate multidisciplinary identification talent, it is essential to effectively utilize network resources and keep pace with advancements in digital and networked forensic practices.

2. CURRENT STATE OF DOCUMENT FORENSIC EXPERIMENT TEACHING

2.1 Outdated Knowledge Structure in Experiment Projects

Traditional document forensic experiment projects are designed based on subcategories of document examination. Key projects include:

- Document creation method identification experiments
- Printed document examination experiments
- Seal and imprint identification experiments
- Altered and defaced document analysis experiments
- Document examination instrument operation experiments (e.g., vacuum electrostatic pressure indentation apparatus, fluorescence microscopes)

However, the content and methods of traditional experiments no longer satisfy the demands of contemporary forensic practices. Emerging areas such as electronic signature verification and robot handwriting analysis have become new research topics, yet these are absent from traditional document forensic experiment curricula.

2.2 Limited Laboratory Accessibility

Forensic laboratories face challenges common to other humanities-based laboratories, such as insufficient justification for purchasing expensive equipment, leading to underutilization and idle assets. Current document forensic experiments are mostly restricted to internal use within law schools, with limited access for non-major students, external institutions, or the public. Low rates of resource and data sharing often result in laboratory facilities being underutilized or even abandoned, effectively wasting resources and indirectly causing a loss of state-owned assets.

2.3 Insufficient Investment and Attention

Forensic identification experiments are primarily offered in legal and police universities, inherently limiting their reach. Universities tend to prioritize science and engineering laboratory development, often overlooking the necessity and importance of humanities-based laboratories, including legal studies. For instance, Nanjing Normal University's Law Experiment Center was recognized as a provincial-level demonstration center in 2006. However, due to limited resources, issues such as inadequate laboratory space and outdated equipment investment have hindered practical training, skill development, and innovation in forensic talent cultivation.

2.4 Single-Faceted Evaluation of Experiment Results

During forensic experiments, the teacher-led approach often results in students merely following "standardized procedures" to complete tasks, inevitably earning high scores. Additionally, the evaluation system for experiment teaching is not comprehensive. While traditional courses require students to submit experiment reports, large class sizes make it difficult for instructors to provide detailed guidance to each student. Consequently, assessments focus more on results than processes.

For document examination experiments, the process is as important as the outcome, encompassing both scientific and legal procedural aspects. The completeness and rationality of procedures during experiments significantly impact the reliability of evaluation results.

3. FEATURES OF VIRTUAL SIMULATION EXPERIMENT TEACHING IN FORENSIC IDENTIFICATION

3.1 Innovative Teaching Methods

3.1.1. Breaking Temporal and Spatial Barriers with Digital Scenarios

For example, in 2020, our institution received approval for the Ministry of Education's national-level first-class virtual simulation experiment project, Virtual Simulation Experiment for Judicial Identification of Document Authenticity in Litigation. This experiment encompasses three key scenarios: the reception hall of a forensic identification agency, the forensic laboratory, and the courtroom. These high-quality 3D images provide a highly realistic reproduction of real environments.

Through a two-hour virtual simulation experiment, students can experience and practice the entire judicial identification process, which would typically take several months in real cases. This approach addresses issues such as the difficulty of acquiring authentic document samples and the susceptibility of physical materials to damage, while also reducing dependency on expensive forensic equipment and facilities traditionally required for legal education.

3.1.2. Enhancing Comprehensive Skills Through Research-Oriented Experiments

Document authenticity identification involves multiple subfields, such as analyzing document creation methods, detecting tampered documents, and verifying the common origin of printed materials, seal consistency, and fingerprint authenticity. The virtual simulation system for document authenticity includes predefined course rules, logical connections between steps, and procedural standards. Students assume specific roles and responsibilities, participating in tasks such as case acceptance, implementation of identification, drafting opinions, and courtroom cross-examination, fostering a well-rounded skillset.

3.1.3. Strengthening Engagement Through Interactive Experiments

Interactive features allow students to develop practical skills through multiple participatory activities.

Case Acceptance: Students role-play as forensic experts, engaging in dialogues with court judges, identifying the scope of examination, understanding legal requirements, and selecting relevant materials.

Courtroom Cross-Examination: In this stage, students respond to questions from judges, litigants, legal representatives, and expert assistants, addressing procedural and substantive issues related to the admissibility and credibility of forensic evidence.

The experiment also includes a platform for interactions between students and instructors, enhancing engagement through collaborative learning.

3.1.4. Emphasizing Practice Orientation with Comprehensive Case Studies

Document forgery techniques evolve rapidly. Virtual simulation software can adapt to these changes by incorporating real-world cases and dynamically updating relevant content. By combining theoretical knowledge with

practical scenarios, students are exposed to a diverse range of case studies, enhancing the integration of virtual and real-world learning.

3.2. Innovative Evaluation Systems

3.2.1. Comprehensive Evaluation Framework

The evaluation system combines modular and holistic assessments, with three levels of evaluation:

Level 1: Assessment points are embedded within individual experiment modules, evaluating specific operations.

Level 2: Performance scores for each module are aggregated.

Level 3: A comprehensive score is given based on the full experiment.

3.2.2. Novel Content Design

Evaluation criteria are tailored to the characteristics of virtual simulation experiments and forensic evidence. Key aspects include:

- Compliance of generated forensic documents with judicial standards.
- Operational performance in specific modules.
- Completion levels in interactive tasks.
- Quality of responses during cross-examination.
- Accuracy of final forensic opinions.

This innovative framework transcends traditional limitations, emphasizing both the process and outcome of teaching.

3.2.3. Intuitive Evaluation Results

Simulated courtroom cross-examination highlights the unique features of legal virtual experiments. Students practice articulating forensic opinions, demonstrating the evidence evaluation process, and responding to procedural queries. Outstanding participants can view simulated court rulings where their opinions are adopted, offering immediate and impactful feedback.

3.2.4. Real-Time Feedback and Iterative Improvement

The evaluation system provides instant feedback online, enabling students to identify areas for improvement immediately. Students can pause experiments, save progress, and resume later. They can also share challenges and insights in real-time discussion forums or leave comments for instructors, facilitating continuous learning and collaboration.

3.3. Extending and Expanding Traditional Teaching

Compared to traditional document examination methods, which often suffer from limited sources, non-replicable materials, and singular results, virtual simulation enables the reuse of complex cases and enhances traditional teaching in three key ways:

3.3.1. Practicality

Unlimited repetition of virtual experiments allows students to refine their practical skills and critical thinking. Virtual tools enable close observation of details such as fingerprint and seal characteristics, reinforcing theoretical knowledge with hands-on practice.

3.3.2. Substitutability

Authentic evidence from real cases is often inaccessible to

students. Virtual simulation bridges this gap by recreating real or adapted cases, allowing students to experiment without risking damage to actual evidence. This approach also supports multiple experimental outcomes, facilitating comprehensive testing and the exploration of various identification methods.

3.3.3. Comprehensiveness

Traditional teaching methods often focus on isolated tasks, such as fingerprint or seal analysis. Virtual simulation integrates multiple elements within a single case, enabling students to conduct exploratory experiments from various perspectives—e.g., fingerprint patterns, seal authenticity, and ink sequence analysis. Students' progress from verifying knowledge to independently designing experiments, formulating conclusions, and refining techniques based on iterative feedback.

This innovative approach to virtual simulation transforms forensic education by breaking traditional barriers, fostering practical skills, and cultivating a new generation of highly competent forensic professionals.

4. THE NECESSITY OF VIRTUAL SIMULATION EXPERIMENT TEACHING IN DOCUMENT EXAMINATION

4.1. Adapting to the Needs of Document Examination Practice

The challenges in document examination practice are constantly evolving. Document forgery techniques are diverse and ever-changing, necessitating continuous adjustments to teaching content and methods. In this context, the construction of practical courses should clarify their overarching goals, closely monitor trends in document examination practices, and integrate the latest forgery techniques and strategies into teaching. This ensures that teaching content is forward-looking, directive, and effective, meeting the demands of contemporary document examination. Virtual simulation experiment teaching fills this gap, emphasizing the practical characteristics of document examination and enhancing the depth of experimental course construction.

4.2. Addressing Shortcomings in Traditional Legal Education

Document evidence is pervasive in all three major types of litigation, and the ability to authenticate document evidence has become a fundamental and necessary skill for legal professionals. Document examination encompasses numerous knowledge points, including understanding examination procedures, drafting legal documents, operating specialized instruments, and participating in courtroom cross-examinations. Traditional classroom teaching primarily covers theoretical and procedural aspects, while practical skills such as operating instruments and courtroom appearances can only be developed through experimental teaching.

4.3. Overcoming Temporal and Spatial Constraints in

Evidence Teaching

Virtual simulation experiments condense months-long judicial identification processes into two class hours, providing a complete operational and training experience. They offer dynamic scenario switching between case reception, forensic laboratories, and courtroom trials—features unattainable in traditional experiments. Students not only learn standardized workflows for tasks like accepting assignments, preliminary reviews of evidence, and document examination but also focus on mastering technical operations, such as using instruments and conducting various types of examinations. This minimizes the risk of procedural errors or operational mistakes in future professional practice.

4.4. Mitigating Risks of Evidence Material Damage

In judicial practice, authentic document evidence is often highly valuable, confidential, and susceptible to damage, making it unsuitable for student experiments. Additionally, many legal education institutions lack specialized forensic laboratories and teaching equipment, limiting opportunities for students to develop evidence-handling skills. Virtual simulation experiments address these issues by avoiding reliance on authentic materials while providing realistic simulations of document examination processes. This eliminates the challenges of acquiring and preserving real evidence materials, reducing dependence on physical resources and facilities in legal education.

5. CONCLUSION

Experiment teaching is a critical component of forensic identification education and an essential pathway for cultivating scientific rigor in students. In the new era, forensic identification talent training must emphasize practical, hands-on learning aligned with real-world applications. Integrating virtual simulation technology into document forensic experiment teaching effectively resolves the challenges of traditional practice-based education.

By complementing theoretical lectures and conventional laboratory experiments, virtual simulation teaching enhances practical training, ensuring better outcomes. This approach also aligns with a student-centered teaching philosophy, offering precise and relevant content through innovative and diverse methods. It expands the depth and breadth of experiment teaching, boosts student engagement and practical abilities, and elevates the quality of experiment education. Ultimately, this promotes the development of document forensic teaching, experimentation, research, and professional practice, ensuring a comprehensive and forward-looking approach to talent cultivation in the field.

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Conflicts of interests

None declared.