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Research Experience and Future Criminalists

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ABSTRACT: With research as its distinguishing characteristic, graduate education in the United States provides the philosophical foundation which, when properly focused, may prepare future criminalists to address significant problems in and advance successfully the practice of criminalistics. Graduate research is the source of much of the knowledge explosion responsible for many state-of-the-art forensic science techniques. In particular, the discoveries and other contributions made by forensic science researchers at universities have been abundant.

Graduate research experiences exemplify one of the means proposed to accomplish goals through the encouragement of creative problem solving ability. The paper includes examples of questions confronting criminalistics with emphasis on the ways the graduate research process may contribute to piloting the profession through transition with sensitivity and understanding.

KEYWORDS: forensic science, symposium, education, criminalistics

For most of this century, the United States has been regarded as the world leader in graduate science education. The national emphasis on generating new knowledge, particularly in the sciences relating to medicine, space, and defense, is probably the driving force behind the knowledge explosion witnessed during this period. Most basic science discoveries are rooted in research at the graduate school level, oftentimes accomplished by graduate students working under the direction of graduate science faculty. The demanding research requirements that graduate schools provide is in sharp contrast to most undergraduate education, where student participation in research is either nonexistent or minimal.

Nonetheless, graduate programs in the natural sciences generally lack the necessary focus to prepare criminalists because they show little awareness of the *forensic* aspects of science. Also, many basic science programs lack the emphasis on analytical techniques so important to new methods development in forensic sciences. Among chemists, for example, there is a rivalry in which synthetic organic chemists view analytical chemists as technicians whose job it is to identify organic reaction products. Only a few of the top universities even recognize analytical chemistry as a bona fide subdiscipline, such as inorganic, organic, or physical chemistry.

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One reason these general science programs have not been fully embraced by criminalists is because they fail to give attention to the added responsibilities of forensic scientists beyond those of conventional scientists. The responsibility of rendering expert testimony in courts of law carries with it the constant need to be prepared for intense scrutiny—a specific challenge that few research-only scientists ever face. Criminalists are especially aware that their answers must be accurate and complete, yet simple enough to be comprehended by the lay juror. Moreover, the expert's entire professional record must reflect unimpeachable integrity. On the other hand, research oriented scientists face less immediate consequences of an "on record " error.

Another problem is that criminalistics is still in an early developmental stage: criminalists face issues that professions of longer standing recognition have resolved, including those involving the role of education and research. Criminalistics leaders have failed to reach agreement to critical issues such as the role of research experience in the development of the profession.

The purpose of this paper is to present a discussion of the research experiences available through graduate forensic science education and how these experiences can be used by those students who become criminalists as a basis to advance the profession, through both practice of criminalistics and assuming a leadership role in this profession.

University Faculty

Those scientists who have chosen primary careers as faculty in graduate programs in criminalistics have dedicated themselves to the advancement of new knowledge in criminalistics. Their dedication is exemplified by a considerable record of basic and applied research. For example, researchers at the University of Illinois at Chicago have made research contributions to the profession in the form of valuable surveys ranging from characteristics of forensic science faculty [*1*] to the usefulness of physical evidence test results [*2*] and advances in fingerprint technology [*3,4*]. Recent work at Michigan State University has involved distinguishing *d*-cocaine from *l*-cocaine [*5*], soil samples by high performance liquid chromatography (HPLC) [*6*], and petroleum products by three-dimensional fluorescence [*7,8*]. At Northeastern University, a high-speed extraction technique for accelerants in fire debris has been developed [*9*]. The University of New Haven has been the site of advancements in the fields of forensic serology and trace evidence. The evaluation of antisera for bloodstain grouping [*10,11*], enzyme assays for identification of gastric fluid [*12*], and a preciptin-inhibition test on denatured bloodstains for determination of human origin [*13*] are examples from the long list of contributions made by faculty from this institution. At the John Jay College of Criminal Justice, City University of New York, forensic science faculty have contributed to advancing new knowledge on such topics as blood droplet dynamics [*14,15*], hair individualization [*16*], fire debris and explosion analysis [*17,18*], and electrophoresis [*19,20*]. Advances in gas chromatographic quantitation using thermal conductivity detection and thin-layer immunoassay procedures were reported from George Washington University [*21-24*]. The University of Alabama at Birmingham's scientists have produced research results on forensic science applications of gas chromatography/mass spectrometry [*25*], trace evidence [*26*], drug chemistry [*27*], and, specifically, detection of cocaine use through hair analysis [*28*]. The University of California at Berkeley's researchers have produced elegant work in forensic serology, including semen identification [*29-32*] and bloodstain drying processes [*33*], fingerprint analysis [*3*], evidence classification [*34*], glass density and reconstruction [*35-37*], enhanced bloodstain detection [*38*], and automotive paint analysis [*39*] in addition to earlier work in almost every area of criminalistics by the late Paul Kirk. This partial list underscores the assertion that a substantial portion of forensic science research does originate from universities [*40*].

The Academic/Laboratory Relationship

There are strengths and weaknesses in the relationship between public service laboratories and academic programs, and the ways in which these two entities engage in research is an important aspect of this paper. One strength is the rich source of questions and problems identified by practitioners. For example, internships provide the beginning for many meaningful research projects. Also, research topics may originate from lectures by the practicing experts and from discussions between academic and government laboratory personnel. Joint supervision of graduate student researchers also promotes the formulation of mutually acceptable research agenda. Without coordination between the administrative leadership of both entities, this system may fail, but given the numbers of joint publications between universities and laboratories, it would appear it is working reasonably well.

The Research Experience

It might be helpful to review for a moment what this graduate research experience entails. Before an applicant can be unconditionally accepted for admission to graduate study, he or she must demonstrate academic excellence. The undergraduate grade point average—including successful completion of specific science courses—should equal or surpass 3.00 on a four-point scale, the graduate record examination score (verbal plus quantitative sections) should equal or exceed 1000, and letters of reference (three) should indicate ability and readiness for graduate study in forensic science.

After matriculation, through a substantial amount of coursework, a student masters various techniques and becomes familiar with current problems; then, the student meets faculty with whom he/she may conduct research. Next, the student could pursue one or more projects on a limited basis, say, for between six and twelve weeks. These smaller projects are more applicable to coursework. They may be part of a take-home examination where the student is asked to develop an analysis scheme for a particular drug, fiber, or bloodstain. Another possibility is the participation in an applied research project such as determining the population frequency of an isoenzyme phenotype or variability of refractive index among a large number of glass samples. These projects might be a partial requirement for completion of a course dealing with the selected evidence type.

After completion of course requirements and before or simultaneous with research activity, a comprehensive examination may be required.

When the student chooses a particular thesis or dissertation project, he or she writes a documented proposal that outlines the background of the problem and the steps planned to answer the questions posed. The student presents the proposal, both in writing and orally, to a committee of faculty who critique and make recommendations about the research.

After approval, the student begins active investigation. The committee's chairman, known as the primary research advisor, meets regularly with the student to monitor the progress and elicit solutions to problems. The relationship between the student researcher and the primary research advisor, where the more experienced researcher acts as mentor, has significant potential for development of creative problem solving ability in the student as together, they solve the research problems that occur.

When the proposed research has been completed, the student prepares a substantial report, called a thesis or dissertation. It is reviewed by the committee members in advance of the student's oral "defense" meeting. That meeting starts by the presentation of the problem, the way it was approached, the results of the investigation, and the interpretation of what the results mean. Committee members may interrupt and ask questions at any time. The questions may cover any aspect of the research or may be expanded to any other subject in the student's graduate education. After the questions have been exhausted, the committee votes on whether to accept the document as is, accept with specified revisions (requiring

approval), recommend additional research that must be completed before another defense, or, in extreme instances, terminate the research endeavor. Many papers derived from these are later published in the journals, not only advancing the body of knowledge, but benefiting the student by seeing their name in print and feeling a part of the professional forensic science community.

Applications of the Research Experience to Future Criminalists

What does this have to do with skills required by future criminalists? Some of the results of this process are that it teaches the student self-direction and motivation, the ability to concentrate on a major problem and complete the task, development of oral and written skills, awareness of the state of the art in a given scientific area, as well as experience in utilizing the creative problem solving approach to generate new knowledge. As an added bonus, this process has created a reasonably good public perception of master's and doctorate holders. Of all of these, the most important characteristic for future criminalists is the ability to become a creative problem solver.

The field is faced with an ever increasing set of problems and challenges, including: more sophisticated attorneys and jurors, new laboratory technologies, limited budgets, and a political climate which favors less government, as well as pressures for a higher level of quality control and standardization of test procedures. All such problems require creative solutions. While there are no simple solutions, the properly designed research experience can equip the next generation with the skills necessary to meet the challenge of these problems.

The research experience can help the future criminalist to make use of new technologies, such as laboratory automation, new instruments, and computerization. The student should acquire the ability to apply new technologies, beyond what can be expected from a short continuing education course, by focusing on related research problems.

When a student works closely with a research scientist with experience as an expert witness, he or she has the opportunity to learn from that faculty member's familiarity with the process of preparing for trial as an expert, for either the prosecution or defense in criminal or civil cases. The student may participate in or observe preparation for court testimony by the research scientist or participate in a critique afterwards or both.

Another example involves quality assurance/quality control (QA/QC). Again, specific courses currently provide a foundation in this area, long recognized as essential to good laboratory practice and currently receiving increased scrutiny. A laboratory oriented research experience should illustrate the critical importance of QA/QC to reliable results.

Yet another example is found in the complex area of trace evidence examination. How often do the diverse demands placed on this examiner require a research project to provide the correct answer? And afterwards, how often have valuable research experiences been lost because those findings were never communicated via the professional literature so that other practitioners might benefit from those experiences?

Conclusion

Graduate forensic science programs, as they exist today, are staffed by scientists who are dedicated to advancing the profession, as evidenced by a sampling of research contributions [*1–40*] made by program faculty. Strides have been made by educators to bring forensic science graduate education into line with the changing demands of criminalistics practice, most dramatically with a change from the earlier practice of attempting to prepare a "generalist" to the current format providing a more focused experience. As recently as 1980, some programs attempted to produce graduates with a general knowledge of trace evidence, serology, drug chemistry, and firearms/tool mark examination. Today, the aim of most programs has focussed on preparing specialists whose formal knowledge is concentrated in one

of these areas. While there is still the need to prepare bench scientists to perform the routine tasks involved in analyzing physical evidence, the need for capable problem solvers and leaders will be more critical in a future filled with increased pressures from both within and outside the profession.

Better communication between crime laboratory practitioners and educational programs is essential to providing the most meaningful research experience possible. Educators, practitioners, and laboratory administrators who are concerned with advancing the profession should try to improve the quality of those communications. The presented and published papers of the education subsection of the American Academy of Forensic Sciences represent one (although infrequent) format for exchanging information. Perhaps other organizations such as the regional forensic science societies and the American Society of Crime Laboratory Directors should consider establishing a regular dialogue on research problems with the existing university programs. Another, less formal exchange occurs when crime laboratory directors provide leadership for educational programs and communicate the changing needs of criminalistics practice to their university colleagues.

Without better communication, the maturation of this young profession of criminalistics will not benefit to the fullest from the faculty and student resources of forensic science academic programs. With improved communication, on the other hand, criminalists can look forward with optimism to leadership, grounded in research and creative problem solving, to pilot the profession through transition with sensitivity and understanding.

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