6-18-2016

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Publisher Citation

Kringen, Jonathan Allen, Christopher M. Sedelmaier, and Kristin D. Elink-Schuurman-Laura. "Assessing the Relevance of Statistics and Crime Analysis Courses for Working Crime Analysts." Journal of Criminal Justice Education (2016): 1-19.

Comments

This is a post-peer-review, pre-copyedit version of an article published in *Journal of Criminal Justice Education*. The definitive publisher-authenticated version of Kringen, Jonathan Allen, Christopher M. Sedelmaier, and Kristin D. Elink-Schuurman-Laura. "Assessing the Relevance of Statistics and Crime Analysis Courses for Working Crime Analysts." Journal of Criminal Justice Education (2016): 1-19. doi:10.1080/10511253.2016.1192211 is available online at: http://dx.doi.org/10.1080/10511253.2016.1192211

ASSESSING THE RELEVANCE OF STATISTICS AND CRIME ANALYSIS COURSES FOR WORKING CRIME ANALYSTS

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Manuscript for submission to:

Journal of Criminal Justice Education

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ABSTRACT

Crime analysts study criminal activity and police function to improve performance. Analysts inform operations, aid resource allocation, and evaluate programs. These tasks require high levels of statistical literacy. Given that most analysts are college-educated civilians, college coursework in statistics and/or crime analysis may represent the foundational knowledgebase within the profession. However, little research has attempted to determine if coursework teaches the skills needed by analysts. Underlying this issue is a limited understanding about what technical skills crime analysts regularly use. Analyzing parallel surveys of 98 criminal justice educators and 146 crime analysts, this study compares the skills taught in undergraduate-level statistics and crime analysis courses to those used by analysts. Comparisons are made between perceptions of the value of coursework. Results indicate discrepancies between the orientation of coursework and the needs of analysts which underscore differences in the perceived relevance of statistics education. Recommendations are discussed.

INTRODUCTION

Crime analysis is the study of crime data and other related information to assist law enforcement in reducing or preventing crime, apprehending criminals, and evaluating departmental policies. Crime analysis has been related to lower rates of crime, more effective policing policies, and increased efficiency in resource allocation, particularly in departments which utilize crime analysis when making decisions (Baltaci, 2010; Santos, 2012; Santos 2014; Veigas & Lum, 2013). Crime analysts compile and analyze information on criminal activity, police response, and department policies reporting results to central command staff, area commanders, and patrol officers. Their results inform tactical operations, strategic planning, resource allocation, and general policy decisions (Lum, Koper, & Telep, 2011; Taylor, Boba, & Egge, 2013; Willis, Mastrodski, & Weisburd, 2007).

To conduct their work, crime analysts use a variety of technical skills including accessing data systems, rendering data in geographic information systems, and performing statistical analyses (O'Shea & Nicholls, 2002; Taylor, Kowalyk, & Boba, 2007). Despite a heavy reliance on these abilities in the career, there are no uniform standards for employment as a crime analyst; however, most crime analysts are college-educated (Dixon & Schaub, 2004; Sever, Garcia & Tsiandi, 2008). Considering that many criminal justice departments at universities and colleges offer technical training in statistics and crime analysis, a relevant question becomes, do these technical courses taught in criminal justice undergraduate programs teach the relevant skills necessary for employment as a crime analyst?

Using parallel surveys of criminal justice educators and working crime analysts, the present study seeks to provide insight into this question. The analysis compares the technical

education in statistics and specialized crime analysis courses in criminal justice programs to the needs of working crime analysts. The techniques, concepts, and software taught are compared, and the orientation of coursework is considered.

BACKGROUND

The use of data to inform policing efforts dates back to the mid-1800s when the London Police created a specialized detective bureau aimed at identifying crime patterns. The bureau collected and analyzed data in attempts to solve cases and quickly began compiling aggregate crime statistics to inform policing strategies. Similar efforts began in the United States in the early 1900s when Vollmer established practices such as pin mapping of crime locations, assignment of crime-based patrol routes, and analysis of incident reports within the Berkley Police Department. However, modern crime analysis did not emerge until much later when Wilson (1963), who coined the term *crime analysis*, recommended that police departments establish statistics units to support crime reduction efforts.

Shortly after Wilson's recommendation, the 1968 Omnibus Crime Control and Safe Streets Act encouraged police organizations to evaluate their policies and to allocate funds for crime reduction support systems accordingly. This legislation spurred an increased interest in crime analysis throughout the 1970s. At that time, funding from the Law Enforcement Assistance Administration (LEAA) allowed for substantial development of dedicated crime analysis units within police departments. However, by 1982 LEAA had exhausted its funding leading to a lack of resources for hiring new crime analysts (Bruce, 2008).

Despite the setbacks in the 1980s, crime analysis units resumed development throughout the 1990s. By the 2000s crime analysts had become common in police departments in the United

States, and the majority of modern departments have dedicated crime analysis units (Dixon & Schaub, 2004; O'Shea & Nicholls, 2003). In addition, many more organizations that lack dedicated crime analysis units assign individuals to work on crime analysis projects, and crime analysis is the primary duty for more than half of these individuals (Taylor et al., 2013). Agencies with more specialized units, that focus on community policing, or that have a large number of written policies invest more heavily in crime analysis units and personnel (Randol, 2014).

Most crime analysis units are centralized and fall under the administrative branch of individual departments (O'Shea & Nicholls, 2002). However, after September 11, 2001 fusion centers designed to combat crime and terrorism by connecting information between organizations emerged. These centers employ crime analysts who primarily engage in intelligence analysis by identifying and prioritizing suspected offenders, potential targets, and suspicious activities (Monahan, 2009; Taylor & Russell, 2012). By 2015, over 70 fusion centers were opened employing crime analysts across the United States.

Crime Analysis Education

In the 1970s, to aid in the newly-formed crime analysis units, LEAA published several crime analysis manuals. The first, *Police Crime Analysis Unit Handbook*, described the advantages of having a crime analysis unit, discussed analytic techniques, and gave instructions on how a crime analysis unit should be implemented in various sized police departments (see Buck, 1973). In 1975, LEAA funded the first national training program in crime analysis which was utilized by almost 400 law enforcement personnel.

While the majority of early trainees obtained crime analyst positions, departments were largely ineffective at integrating crime analysis into their operations. As a result, less than half of the trainees stayed in their positions for more than a year, and commentators recommended more training to advance crime analysis and its use within policing (Bird, 1975). Despite the recommendations, crime analysts working in the 1980s rarely had any formal training. During that time, crime analyst positions were largely filled by officers restricted to light-duty or who were close to retirement, and skills for the position were learned on the job.

The climate surrounding crime analysis changed in 1990 with the formation of the International Association of Crime Analysts (IACA). IACA increased resources and training opportunities for crime analysts. Other professional organizations followed including the International Association of Law Enforcement Intelligence Analysts (IALEIA), the Northwest Regional Crime Analysis Network (NORCAN), the California Crime and Intelligence Analysts Association (CCIAA). In addition agencies, such as the California Department of Justice, also began to offer training programs in crime analysis.

Alongside professional organizations, colleges and universities started offering coursework in crime analysis. While many crime analysis courses represented individual course offerings within criminal justice departments, by 2012 over 20 colleges offered some type of formal crime analyst training program or certification (Klofas, 2012). To help guide the educational efforts, IACA created a Standards, Methods, and Technology (SMT) committee in 2010. The committee's goals included developing best practices in crime analysis education and formulating educational recommendations.

SMT has released several recommendations for crime analysis education programs including guidelines for qualifications of crime analysis educators and for crime analysis

curriculum. Regarding educators, IACA asserts that crime analysis educators should have practical experience working as crime analysts, should maintain relationships with local police departments to generate educational opportunities for students, should supervise students analyzing data for the local police departments, and should be members of IACA. Regarding curriculum, IACA asserts that, in addition to coursework in geographic information systems (GIS) and specialized crime analysis techniques, crime analysis curriculum should include a strong emphasis on foundational courses including criminological theory, research methods, statistics, writing skills, and technology (Klofas, 2012).

Evidence suggests support for IACA's curricular recommendations. Educators note that learning crime analysis and crime mapping requires interdisciplinary education (Althausen & Mieczkowski, 2001; Ferrandino, 2015). While some instructors suggest that students take courses in criminology, sociology, or policy to prepare for or enhance courses in crime mapping (Althausen and Mieczkowski, 2001; Ferrandino, 2015), others stress the methodological issues including data collection methods and the complexities of using different data types (Barcus & Muehlenhaus, 2010). Given that crime mapping utilizes advanced software, educators note that crime analysis courses should include instruction in software as well as the use of geodatabases, the process of exporting files, and procedures for managing and summarizing data generated from GIS programs (Ferrandino, 2015).

Crime Analysts

Modern crime analysts can be either sworn officers or trained civilians; however, the majority of departments employ civilian analysts (Dixon & Schaub, 2004; O'Shea & Nicholls, 2003). The majority of working crime analysts hold at least a bachelor's degree, and most have

some non-academic training in crime analysis (Sever, et al., 2008; O'Shea & Nicholls, 2002). Most non-academic crime analysis training is done on the job, and the training is often aimed primarily at entry-level personnel. Furthermore, there are no standardized training or certification requirements in the field (Dixon & Schaub, 2004).

The lack of standardized certification requirements results in substantial variation in skills between analysts, and training in important skills recommended by IACA including statistical analysis, crime mapping, and data visualization are lacking in police departments (O'Shea & Nicholls, 2002). Tactical analysis, the most common type of crime analysis in local law enforcement, requires a high level of proficiency in statistics which is uncommon, and, despite employing primarily college-educated civilians as analysts, many departments still lack personnel with the requisite statistical skills to produce or interpret meaningful tactical analysis.

Beyond tactical analysis, limited statistical skills may impact crime analysts' ability to utilize GIS for advanced crime analysis techniques. While basic functions, such as mapping the locations of crimes, can be done in GIS without statistical knowledge, advanced crime analysis techniques require an understanding of statistics such as exploratory spatial data analysis (ESDA) (Ratcliffe, 2004). Incorporation of spatial statistics within GIS allows crime analysts to determine how geographic attributes and other factors relate to locations to crime, to analyze hotspots or risk terrain models, and to conduct geographic profiling (Ratcliffe, 2004; Vilalta, 2013).

Statistical Literacy, Producers, and Consumers

Limited proficiency in statistics is a general problem that extends far beyond police departments. Underlying this issue, many individuals lack functional numeracy, the ability to

comprehend meaning from a reported set of figures, despite the prevalence of numeric information in society (Utts, 2003). Beyond functional numeracy, many individuals lack statistical literacy which includes the ability to logically discuss the meaning of data, the implications of findings, and limitations of an analysis (Gal, 2002). Lacking statistical literacy is related to holding fallacious beliefs based on statistical conclusions. Individuals may assume that numeric data equates to precision and accept statistical results as truth or they may refuse to believe statistical conclusions that conflict with their personal beliefs (see e.g., Abelson, 1995; Ditto & Lopez, 1992; Ditto, Scepansky, Munro, Apanovitch, & Lockhart, 1998; Gal, 2003; Scherer et al., 2013 Sowey, 2003).

Many educators believe that students should be taught statistics as part of their general education to achieve a level of civic numeracy (Boland & Nicholson, 1996; Boland, 2003; Sowey, 2003). Civic numeracy is the ability to analyze, evaluate, and discuss substantive issues that are portrayed using statistics. Civic numeracy contrasts with professional numeracy, the ability to gather, analyze, and report data. Whereas individuals exhibiting civic numeracy can critically consider results and understand policy implications of analyses, individuals with professional numeracy can formulate research problems, gather valid data, utilize correct analytical methods, and accurately communicate results to targeted audiences (Steen, 1990).

The differences between civic and professional numeracy highlight that some individuals need a more in-depth understanding of statistics than others. Gal (2002) presents a typology of statistical users based on this distinction. The first group, consumers, consists of anyone who has a demand for statistical information. The second group, producers, consists of individuals that analyze data and report results creating new statistical information. While both groups need civic numeracy, producers require professional numeracy. As the primary creators of statistical

knowledge, producers must better understand complexities of data and analysis (Batanero, 2002; Rumsey, 2002; Sowey, 2003).

Beyond analyzing data, producers assume the primary responsibility for communicating new statistical information to consumers which requires strong technical communication skills (Kirk, 1991; McCulloch, Boroto, Meeter, Polland, & Zahn, 1985). Producers interact with consumers who vary in statistical literacy, and assume additional responsibilities when working with individuals who exhibit limited numeracy (Kirk, 1991; Boland, 2003). Producers also carry the responsibility of discerning when individuals misunderstand results and must effectively communicate to correct these misunderstandings (Sowey, 2003).

The typology of consumers and producers is relevant to police personnel. Civic numeracy is essential in policing, as patrol officers, investigators, and command staff must be able to consume and understand statistical information to carry out their respective roles. Particularly important is civic numeracy among command staff which must make decisions about operations based on statistical summaries. In contrast, the statistical production role falls primarily upon crime analysis units. Individuals working in these units must exhibit high levels of professional numeracy, as not only must they make measurement and design choices in their analyses, but they must also be capable of effectively communicating their findings to their department's consumers. This requires not only the ability to understand statistics, but the ability to explain their meaning and use to others who may not possess a higher level of numeracy.

The typology of consumers and producers is likewise relevant for educators. College statistics courses vary in both content and delivery. While similar core concepts (e.g., basic data description, probability, classical statistical tests, significance, and statistical power) are often taught in dedicated classes; instructors vary in their knowledge base and ability to teach the

topics (Sowey, 2003; Utts, 2003). There is often a limited transfer of information from instructors to students resulting in a lack of conceptual understanding among students (Bude, Imbos, van de Wiel, & Berger, 2011; Gal, 2003). Many statistical courses neither teach nor test for critical assessment ability, and courses rarely seek to focus specifically on either civic or professional numeracy. As a result, they often fail to create either good consumers or good producers (Gal, 2003; Steen, 1990).

Crime Analysis, Statistics, and Criminal Justice Education

Crime analysis, as an academic specialization within criminal justice, has seen substantial growth. However, while most working crime analysts are college-educated civilians, limitations in the statistical abilities among crime analysts persist. Considering that non-academic training opportunities vary and that there are no standardized set of requirements for certification as a crime analyst, an important question concerns whether statistics or specialized crime analysis courses offered as part of criminal justice education address the relevant needs of crime of crime analysts. Specifically, there are four questions:

(1) What statistical techniques are taught in statistics or crime analysis courses in criminal justice programs, and are these commonly used by working crime analysts?
(2) What software, if any, is taught in statistics and crime analysis courses in criminal justice programs, and is this software commonly used by working crime analysts?
(3) Are statistics courses in criminal justice programs oriented toward creating consumers or producers of statistics, and is this orientation consistent with the needs of working crime analysts?

(4) How do criminal justice educators and working crime analysts view the value of statistics courses taught in criminal justice programs?

DATA & METHODS

To address these questions, data were collected through two parallel surveys administered in 2013. The first survey was administered to criminal justice educators who were registered members of the Academy of Criminal Justice Sciences (ACJS) and taught statistics or crime analysis courses, and the second survey was administered to crime analysts who were registered members of IACA. Both surveys were administered online, and respondents were solicited via email. In total, 98 ACJS members responded to the educators' survey, and 146 IACA members responded to the crime analysts' survey.

The educators' survey included questions assessing four domains. The first domain concerned which specific statistical techniques were taught in their courses. The second concerned which software systems were taught in their courses. The third domain assessed educators' opinions about whether statistics courses in criminal justice education should be oriented toward training consumers as opposed to producers of statistics. The final domain concerned educators' beliefs about the value of statistics training in criminal justice education. The parallel analysts' survey included questions assessing the same four domains from the point of view of working analysts. The first domain concerned which specific statistical techniques were used by the analysts. The second concerned which software systems were used by the analysts. The third domain assessed analysts' opinions about the proper orientation of college courses, and the final domain concerned analysts' beliefs about the value of statistics training to

working professionals including themselves. Additional questions assessed information about respondents' employment and organizations.

To assess the first domain, educators were asked in the education/training section to indicate whether their undergraduate statistics courses included instruction in specific statistical techniques from a list of 29 statistical techniques compiled from a sample of undergraduate criminal justice and social science statistics textbooks. The list included basic methodology, data management and presentation techniques, aspatial statistical techniques, and various types of spatial analyses. Analysts were presented with the same list of statistical techniques and asked to indicate whether they used these techniques at least daily, weekly, monthly, yearly, or never. Educators that indicated that they also taught a crime analysis course were asked to indicate whether their crime analysis course included instruction on the same statistical techniques as well as specific crime analysis techniques. Similarly, educators were asked to indicate which software packages, if any, they used in their statistics classes from a list of common statistics programs. Educators who indicated they also taught crime analysis were asked to indicate which software packages, if any, they used in their crime analysis classes from a list of specialized packages used in crime analysis. Analysts were presented with both lists of software (i.e., statistical programs and specialized programs) and asked to indicate whether they used these programs in their jobs.

In both surveys, perceptions about coursework orientation were measured using participants' responses to a series of prompts. For example, the educators' survey included a prompts stating, "The primary goal of our undergraduate statistics curriculum is to create critical CONSUMERS." Both surveys included additional prompts such as, "The primary goal of an undergraduate statistics curriculum <u>should be</u> to create critical CONSUMERS." Similar prompts

were included that assessed educators' and analysts' attitudes that undergraduate statistics courses should be oriented toward creating producers. Responses were measured using five-point Likert scales with one indicating strong disagreement and five indicating strong agreement with the prompt.

Both educators and analysts were asked to respond to prompts assessing their perceptions about the relevance of undergraduate statistics education for criminal justice professionals. Additionally, analysts were asked about the relevance of their undergraduate statistics training to their careers. Finally, educators were asked to respond to a prompt stating, "Our undergraduate statistics curriculum needs revision." As with the previous orientation measures, all responses were measured using similar five-point Likert scales. The parallel survey instruments are presented in Figure 1.

[INSERT FIGURE ONE ABOUT HERE]

FINDINGS

All 98 ACJS members that responded to the educators' survey taught or had previously taught an undergraduate statistics courses in criminal justice. Forty-five educators (45.9%) also indicated they taught or had previously taught a crime analysis course. Of all the educators, the majority (91.8%) worked at four-year public or private institutions as either assistant (31.6%), associate (28.6%), or full (31.6%) professors. The average time working in their organization was 9.5 years (SD = 8.8). The majority of respondents (54.1%) currently taught an undergraduate statistics course; however, fewer (19.4%) currently taught a crime analysis course. While almost

all of the respondents worked at institutions in the United States, one respondent worked in Canada.

Only 24.5% of respondents indicated that their institution required a statistics class as part of the overall criminal justice curriculum. Of those working in a program with a required statistics course, the majority (93.3%) indicated only one statistics course was required. Students were typically required to take their statistics course in the third year (53.3%), with fewer taking it in the second (33.3%) or fourth (13.3%) year. The required statistics courses were generally (86.7%) criminal justice specific.

The majority (55.1%) of the respondents reported their program did not offer a course in crime analysis. Of the programs that did, the majority (52.9%) did not require a statistics course as a pre or co-requisite for the crime analysis class. Most programs that offered coursework in crime analysis offered it in students' third (33.3%) or fourth (46.7%) year, with fewer offering it to students in their first (6.7%) or second (13.3%) year.

Of the 146 IACA members that responded to the crime analysts' survey, the majority worked at local agencies (60.3% at municipal police departments and 21.2% at sheriff's or county police departments). Only 6.8% were employed at state-level agencies, and fewer (2.1%) were employed at federal agencies. The remaining 9.6% were employed by foreign law enforcement organizations or by private agencies. Most of the IACA respondents (89.7%) were currently employed full time as crime analysts, and most (89.0%) were civilians. The average time working in their organization was 7.1 (SD = 4.8) years, and the average agency employed 7.0 (SD = 10.8) analysts. While almost all of the respondents worked within the United States, individual respondents reported working abroad in Canada, Western Europe, the United Kingdom, and Turkey.

The majority of the crime analyst respondents had taken an undergraduate-level statistics course (76.7%), but less than half took a graduate-level statistics course (43.8%). Many reported statistical training outside of college programs, including on the job training (46.6%), training by professional groups (42.5%), and training by private businesses (26.0%). Fewer respondents had taken either undergraduate (26.0%) or graduate (19.9%) level crime analysis courses. Most had been trained as crime analysts by professional groups (74.7%), on the job training (69.2%), or by private businesses (58.9%). Other less common forms of crime analysts and statistical training reported included certification programs, state law enforcement agencies, military organizations, and self-study.

Domain One: Statistical Techniques

The results suggested that undergraduate criminal justice statistics and crime analysis courses, while covering some material used by crime analysts, tended to focus attention on material that was not commonly used by crime analysts (see Table 1). Likewise, many courses did not cover basic methodological issues important to working analysts. Although less than half of statistics (49.1%) and only a small percent of crime analysis (8.2%) courses taught material on basic research methods, almost all crime analysts used basic methods at least yearly (87.0%), with over 80% indicating at least monthly use. In contrast, the majority of statistics courses focused on the logic of hypothesis testing (75.5%), which few crime analysts reported using in their profession (26.0%). This seemingly related to educators' tendency to focus on classical tests of hypotheses (e.g., means comparisons, analyses of variance, regression techniques, and chi-square) in statistics courses; few of which were commonly used by crime analysts. Less than half (30.4%) of crime analysis courses taught any statistical concepts or techniques. Basic data

skills received limited attention in either statistics (41.5%) or crime analysis (6.1%) courses; however, the majority (73.6%) of statistics courses did include instruction on visual presentation of data. In contrast, few (13.3%) crime analysis courses curriculum incorporated training on data presentation techniques.

[INSERT TABLE ONE ABOUT HERE]

Domain Two: Software

Similar to the findings concerning differences between techniques taught and those used by crime analysts, criminal justice statistics courses tended to teach students the use of software not commonly used by crime analysts (see Table 2). Most criminal justice statistics courses taught SPSS (62.3%), but few taught the use of generic spreadsheet packages like Microsoft Excel (34.8%). In contrast, very few crime analysts actually used SPSS (13.7%). However, almost all analysts used some type of spreadsheet package in their work (95.2%). Crime analysis courses were more likely to include the use of a generic spreadsheet package (66.7%). Although crime analysts regularly used specialized software including ArcGIS (88.4%), CrimeStat (21.9%), and CrimeView (21.9%), none of these programs were regularly taught in crime analysis courses.

[INSERT TABLE TWO ABOUT HERE]

Domain Three: Orientation

Overall, educators and crime analysts differed in their beliefs about the proper orientation of statistics training. Educators largely agreed that their existing statistics courses were oriented toward creating consumers of statistics (mean = 4.0, *SD* = 0.8) rather than creating producers (mean = 3.2, *SD* = 0.8). Educators seemingly viewed this orientation as appropriate expressing a belief that statistics courses in criminal justice should be orientated toward creating consumers (mean = 4.1, *SD* = 0.9). Crime analysts significantly differed from educators ($t = -2.88$, $p < 0.05$) demonstrating less agreement that creating consumers should be the goal. In contrast, crime analysts indicated that undergraduate statistics courses should be oriented toward creating producers (mean = 3.9, *SD* = 0.9), significantly differing from educators' position ($t = 4.27$, $p < 0.05$).

Domain Four: Perceived Value of Coursework

Consistent with the disparity between techniques and software taught and used by crime analysts, educators and crime analysts differed in their opinions on the value of undergraduate statistical education. Crime analysts expressed a weak belief (mean = 3.5, *SD* = 1.0) that their undergraduate statistics coursework was relevant to their careers as crime analysts which was significantly less ($t = -5.37$, $p < 0.05$) than educators' strong belief (mean = 4.3, *SD* = 0.6) that the undergraduate statistics courses they taught were relevant to students' future careers in criminal justice in general. Crime analysts also demonstrated limited agreement with the relevance of the coursework for criminal justice practitioners in general (mean = 3.7, *SD* = 0.9), also significantly differing from educators' view ($t = -3.58$, $p < 0.05$). Despite their personal beliefs about the relevance of coursework in statistics, educators did indicate a belief that undergraduate students do not view statistics coursework as relevant (mean = 2.4, *SD* = 0.9).

Despite these findings, educators disagreed that their undergraduate statistics curricula need revision (mean = 2.9, *SD* = 1.1).

DISCUSSION

The present study attempted to compare the curriculum and orientation of criminal justice statistics and crime analysis courses to assess their relevance for working crime analysts. The study compared techniques, concepts, and software to determine whether current curricula meets the needs of students interested in pursuing careers in crime analysis. Four key areas were evaluated: (1) whether techniques taught were commonly used by analysts, (2) whether any software taught was commonly used by analysts, (3) whether educators and analysts agreed on the current orientation of criminal justice statistics courses, and (4) whether the attitudes of educators and analysts concerning the relevance of statistics courses were similar.

The study indicated that techniques commonly used by crime analysts, such as basic methodology, data collection, cleaning, and organization, are taught in less than half of the statistics and crime analysis courses. While some of the issues may be addressed in research methods courses, failing to concentrate on data gathering and management in statistics courses hinders training producers and also limits the development of critical assessment skills in consumers (see Gal, 2003). Instead, in their statistics courses, educators most often focused on means testing, regression, and related techniques. While these techniques are foundational to higher-order statistical analyses, basic data gathering and management practices are foundational to the techniques actually being taught.

Whereas most crime analysts used spreadsheet packages to conduct their work, less than half of the statistics courses taught spreadsheet programs. Crime analysis classes were more

likely to focus on spreadsheet programs, but, given that statistics courses were more common than crime analysis courses, the majority of students seemingly receive little training in spreadsheets. Instead the majority of courses include SPSS, a propriety statistics program rarely used by crime analysts or in criminal justice agencies in general. A contributing factor to the popularity of spreadsheet packages in the field over propriety statistics packages may be the associated costs. Whereas specialized statistical software licenses can cost thousands of dollars, spreadsheet programs can cost significantly less. Moreover, many agencies already own multiple licenses for Microsoft Excel due to the overwhelming market share held by Microsoft Office.

The study indicated disparity between the orientation of statistics courses and the basic needs of crime analysts. Undergraduate statistics courses in criminal justice are oriented towards creating consumers of statistics. However crime analysts, by the nature of their vocational responsibilities, must function as producers of statistical information. Thus, criminal justice statistics courses lack an essential orientation toward producing crime analysts. The dominant orientation toward producing consumers may reflect the underlying recognition that most students who take undergraduate statistics courses in criminal justice will not pursue careers in crime analysis. As such, focusing on civic numeracy may represent a more utilitarian approach to statistics education as creating critical consumers of statistical information may benefit more students overall.

Given the differences in belief about the proper orientation of statistics courses and the disparity in techniques and software taught, it is unsurprising that crime analysts reported a weak belief that undergraduate statistics coursework was relevant to their current profession. Educators, who held strong personal beliefs about the value of undergraduate statistical education to students' future careers, acknowledge that they perceive undergraduates as not

seeing statistics courses as relevant. Despite this acknowledgement, criminal justice educators did not generally think their statistics curriculum required revision.

Recommendations

The results of the study indicate several recommendations for educators. As noted previously, it may be better to orient primary statistics courses in criminal justice education toward creating consumers. Given the limited number of students in any particular program likely to move on to careers as producers, generally students may be better served if required courses focus on instilling high levels of civic instead of professional numeracy. Specifically orienting introductory statistics courses toward producing consumers limits the value of teaching proprietary analysis software. Instead, educators should focus on developing more general skills by using spreadsheets (such as Microsoft Excel) to analyze real-world data and solve real-world problems. This approach would also enhance critical thinking about results, potentially increasing civic numeracy among students. Given the abstract nature of many statistical concepts, students might also better see the relevance of statistical education to the criminal justice field through the analysis of data to address questions they better understand. Further, this approach would provide essential training in the use of spreadsheets, a skill that may be more generally relevant across a variety of career choices. Additionally, the compatibility of spreadsheet formats with specialized statistical software packages and GIS suggests that this training would be beneficial to students who pursue additional technical training involving specialized software later in the education.

Programs offering certification in crime analysis that adopt the civic numeracy approach in their primary statistics courses should also consider offering secondary statistics courses to

develop professional numeracy. This would provide the opportunity for crime analysis students seeking to focus their educational efforts on becoming producers after having learned the basic skills required to effectively work with data. Teaching a specialized statistics software package (such as SPSS, Stata, SASS, or R) in these courses would likely enhance learning, since students would have previous instruction in spreadsheets from their general statistics education. The key spreadsheet skills learned earlier would likely aid these students in understanding both the function of the software and issues in the analyses being taught. While a second course in statistics would benefit crime analysis students, it would also be beneficial to a wide variety of other criminal justice students such as those considering graduate education. Fundamentally important to this consideration is the capacity of primary statistics courses to instill civic numeracy in students. Assessing the extent to which present or future introduction criminal justice statistics courses accomplish this goal remains an important task requiring empirical investigation.

Inherent to the discussion of crime analysis education is the importance of crime mapping and GIS to professional crime analysts. As indicated by the evidence, the vast majority of crime analysts utilize ArcGIS; however, many crime analysis courses seemingly do not include training in GIS. This issue is problematic. Beyond the limited training, substantial questions surrounding the ability to teach advanced crime analysis techniques utilizing GIS remain. As the literature suggests that only limited analysis can be accomplished in GIS software without statistical knowledge and GIS education is enhanced by additional education in statistics, crime analysis courses that teach mapping may be most successful in preparing students if crime mapping is taught after a fundamental understanding of statistics is already instilled. As such, programs

should also consider whether crime analysis students would be better served if statistics courses were prerequisites for crime analysis courses.

If crime analysis courses are meant to train in professional numeracy rather than as survey courses in crime analysis as a subject, a solid foundation in statistics is required. While crime analysis courses should not be follow-up statistics courses, natural opportunities abound to reinforce and expand upon the concepts included in earlier statistics curricula. Further, better prepared students would increase opportunities to teach more advanced crime analysis techniques utilizing spatial statistics thereby increasing employment opportunities among crime analysis students. As well this approach may render greater capability among working crime analysts thereby impacting the overall effectiveness of crime analysis in policing. As with the previously-recommended strategies, this approach should be evaluated to determine its ultimate impact on the abilities and employability of students.

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