



From Ground to Air: Developing a Drone Curriculum for Law Enforcement Education

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Abstract: Unmanned Aircraft Systems (UAS) have proven very beneficial for law enforcement activities and are used for search and rescue, surveillance, and crime scene reconstruction. As such, integrating this innovation into the law enforcement curriculum at two-year community colleges is becoming significantly important. This study surveyed 94 law enforcement officers and asked them to rank how vital 31 curriculum items were to include in a UAS certificate program. The researchers found three key conclusions from the top third-ranked curriculum items. First, the study participants thought regulations were critically important to include in the curriculum. “Federal and state UAS regulations” was the highest-ranked item in the survey, and “concepts assessed with FAA Part 107 licensing exam” ranked third highest. Learning to operate a drone is very important, with “basic flight skills,” “intermediary flight skills,” and “advanced flight skills” listed as separate curriculum items. The third key conclusion is that students should know how to conduct general missions, supported by high rankings for night missions, ethics, mission planning, risk management, and overwatch and command center techniques. This emphasis on practical drone operation skills underscores their growing importance in law enforcement training. It reflects the increasing need for a curriculum that thoroughly prepares students for real-world law enforcement scenarios, equipping them with the ability to effectively employ UAS technology in various operational contexts.

Keywords: drone, Unmanned Aircraft Systems (UAS), Uncrewed Aerial System, law enforcement, curriculum

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Introduction

In recent years, there has been a notable rise in the use of drones within various industries, with significant uses in law enforcement. The top five uses of drones in law enforcement are surveillance, search and rescue operations, traffic monitoring, crime scene analysis, and crowd monitoring [1]. Drones are deployed in search and rescue missions to swiftly cover large territories and deliver immediate information to assist in finding individuals who are missing or criminal suspects [1]. Drones are used for traffic monitoring to observe traffic patterns, detect violations, and reconstruct accidents [2]. In crime scene analysis, drones provide an aerial perspective to capture comprehensive images and footage, aiding in evidence collection and analysis [3]. Additionally, drones are employed for crowd monitoring during public events or demonstrations to ensure public safety and security [4]. Drones have increasingly become essential components of police activities due to their ability to provide aerial surveillance, which aids in monitoring large areas efficiently and cost-effectively [5].

This study aims to provide faculty members in two-year college law enforcement programs with a comprehensive set of curriculum topics ranked in order of importance. A questionnaire was distributed to law enforcement agencies across the southeastern United States—including Tennessee, Florida, North Carolina, South Carolina, Virginia, and Georgia—to evaluate the significance of including 31 specific topics in a drone curriculum. This paper concentrates on the detailed discussion and analysis of the data collected from these responses.

Literature Review

What is a Drone?

The FAA defines a UAS as an aircraft operating without direct human control onboard or inside it [6]. The origin of the word “drone” is often linked to the DH.82B Queen Bee radio-controlled aircraft used by the British during World War 2 for target practice [7]. This paper will use the Part 107 definition, which describes an uncrewed aircraft weighing less than 55 pounds, excluding many military-grade planes like the Predator and Reaper. Most UAS following Part 107 rules are either fixed-wing, multirotor or a hybrid of both. Multirotor



drones use vertically oriented propellers to go up, like helicopters, while fixed-wing drones create lift by passing air over a horizontal wing, like airplanes. A recent study revealed that over 90% of public safety agencies employing drones opt for the multirotor variety [8]. Multirotor drones are popular because they can take off and land vertically, stay in one spot, and move well around obstacles. Typical payloads include red, green, and blue (RGB) cameras with high-zoom capabilities, low-light sensors, and infrared (thermal) imagers [9]. High-zoom cameras are crucial for law enforcement, helping with surveillance and covert operations. Low-light and infrared cameras are beneficial for nighttime tasks and search and rescue missions. Additionally, still pictures taken by these drones can be turned into 3D models of accidents or crime scenes using structure-from-motion software [9].

Part 107

Most non-hobbyist UAS activities fall under the governance of Part 107, occasionally supplemented by additional state and local regulations. Part 107 serves as the regulatory framework for operating UAS weighing less than 55 pounds. The regulation outlines the requirements for pilot certification, operational limitations, and aircraft specifications. These include passing an aeronautical knowledge test, restrictions on flying drones over people, conducting night missions, adhering to maximum altitude limits, and maintaining visual line-of-sight with the pilot [10]. This regulatory framework aims to ensure the controlled incorporation of drones into the national airspace system while still providing a large amount of operational freedom.

Certificate of Authorization

Alternatively, law enforcement agencies utilize UAS by adhering to Part 91 guidelines, which involve obtaining a Certificate of Waiver or Authorization (COA). A COA, granted by the FAA, permits certain public agencies to operate beyond the confines of the Part 107 rules. Operators flying under a COA are exempt from the requirement of possessing an FAA remote pilot certificate and are not bound by Part 107 restrictions, such as the 400-foot altitude limit. However, obtaining a COA involves a comprehensive safety case analysis encompassing operational procedures, pilot qualifications, and the specific use case of the drone. COAs grant greater operational flexibility than Part 107, allowing for activities like night flights or beyond visual line of sight under FAA-approved conditions [11]. From a law enforcement perspective, the FAA's Part 107 regulations for small-unmanned aircraft provide simplicity and accessibility, particularly beneficial for smaller departments or occasional drone use. The straightforward procedure for acquiring a Remote Pilot Certificate, along with clearly defined operational limitations, facilitates the legal deployment of drones in an efficient and streamlined fashion [12]. Nevertheless, restrictions on night operations, flying over people, and flights beyond visual line-of-sight may impede effectiveness in specific law enforcement scenarios. In contrast, a Part 91 COA provides greater operational flexibility, especially beneficial for emergency or sensitive law enforcement operations like surveillance or search and rescue missions. However, the COA application process is more time-consuming and necessitates a detailed safety case, which could pose challenges for smaller departments with limited resources [12].

Proliferation of Drone Use Across Industries

Drones have steadily gained popularity across different sectors owing to their diverse uses and benefits. A partial list of industries and applications includes healthcare, agriculture, construction, disaster management, defense, delivery, entertainment, photography, marketing, rescue, and research [13]. Agriculture, construction, and manufacturing are the leading industries deploying drone technology [14,15,16].

Agriculture

Drones are increasingly employed in agriculture for diverse purposes, including mapping soil properties, assessing crop health, targeted spraying of fertilizers and pesticides, livestock monitoring, and predicting crop performance [17,18]. Additionally, drones outfitted with multispectral sensors have shown considerable advantages in forecasting crop yields and analyzing spatial disparities across fields, thus enhancing the management of silage production for livestock feed [19]. Jarial (2023) highlighted the benefits of drones for precision irrigation, livestock tracking, crop disease surveillance, and aerial monitoring [20]. Moreover, drones have been employed to monitor crop biomass, growth, and quality, as well as to identify weed populations for targeted herbicide applications and improve resource management [21].



Construction

Drones have become an integral part of the construction industry, providing various uses such as site planning, surveys, inspections, safety assessments, progress monitoring, and precise volumetric data collection during excavations [22]. Using drones in the construction industry yields several advantages, including cost-effectiveness, diminished risk to personnel, and increased efficiency in data gathering, owing to their superior spatial and temporal resolutions in contrast to other remote sensing methods approaches [15]. Moreover, drones equipped with infrared cameras and LIDAR offer applications in construction sites, particularly for building inspection and monitoring [23].

Manufacturing

Incorporating drone technology into the manufacturing sector has resulted in notable progress. Drones have been employed across various manufacturing activities, such as inventory management, facility inspections, logistics, and production monitoring. These uses have enhanced operational efficiency, bolstered safety measures, and enabled real-time monitoring of manufacturing operations [16]. In the manufacturing industry, drones have been utilized for tasks such as payload lifting and transportation [24]. Additionally, Majeed et al. (2021) highlighted the application of drones in industrial gas sensing [25].

How Drones Are Used in Law Enforcement

In 2019, DRONERESPONDERS, a leading UAS public safety support organization, released the results of a comprehensive survey of drone use for first responders. A significant finding was that most public safety UAS programs are informal and lack the structure associated with more established technology and practices [26]. Subsequently, DRONERESPONDERS' parent organization, AIRT, conducted an extensive survey of more than 300 professionals in law enforcement, emergency management, and fire safety [8]. The study found that drones' most common practical applications were search and rescue, incident command and control, and crime scene investigation. Other applications included damage assessment, non-forensic mapping, surveillance, public information, structural fire response, SWAT support, special event planning, HAZMAT response, and wildfire response [8].

During 2018 and 2019, the Police Executive Research Forum (PERF), together with the U.S. Department of Justice's Office of Community-Oriented Policing Services and the U.S. Department of Homeland Security's Office for State and Local Law Enforcement, initiated a comprehensive initiative to explore the use of UAS technology in law enforcement. This initiative involved disseminating a survey among law enforcement agencies and hosting a two-day conference to address the challenges and opportunities related to police use of drones. The project highlighted three components, which involved conducting an informal survey of 860 law enforcement agencies across the country, interviewing police executives and staff in agencies with drone programs, and organizing a conference where police executives, federal officials, and other experts from across the country discussed various aspects of police drone usage [27]. The primary objective of this effort was to provide guidance and insights to police agencies interested in implementing their drone programs [28].

The PERF report primarily focused on the law enforcement application of drones. It noted that search and rescue was the primary application for drones, with over 90% of participants acknowledging its implementation in their drone activities. Furthermore, other types of missions where drones were extensively used, covering 80% or more of the respondents, included reconstructing crime scenes, investigating suspects, responding to disasters, and reconstructing traffic collisions. The report also outlined additional mission types such as HAZMAT response, bomb observation, fugitive apprehension, crowd monitoring, and surveillance [27]. Table 1 depicts the frequency law enforcement agencies reported using drones to support various mission types, as outlined in the PERF report [27].



Table 1. Common Purposes for Using Drones in Policing^a

| Drone Purpose | Percentage |
|--|------------|
| Search and Rescue | 91% |
| Crime Scene Photography and Reconstruction | 85% |
| Investigating Armed and Dangerous Suspects | 84% |
| Disaster Response | 84% |
| Traffic Collision Reconstruction | 81% |
| Hazardous Material and Bomb Observation | 68% |
| Fugitive Apprehension | 63% |
| Crowd Monitoring | 51% |
| Surveillance | 27% |
| Other | 14% |

^aFrom PERF (2020), the percentage values of the surveys are given

Public Perception

The deployment of drones by law enforcement agencies raises important concerns about privacy and trust. It is essential for these agencies to engage with their communities before starting a drone program to build support and understanding of the purposes, techniques, timing, and places of drone usage [28]. Law enforcement agencies should develop detailed written guidelines specifying when drones can be used, their intended purposes, the kinds of data or footage that will be gathered and retained, methods for protecting this information, protocols for controlling access, and other pertinent factors. Securing community support and endorsement for the restricted application of drones is essential for maintaining trust-based solid relationships with community members while leveraging this highly beneficial new technology [28].

Privacy and Ethical Considerations

The use of drones by police for surveillance and law enforcement purposes has raised significant ethical considerations. The potential for drones to invade individuals' privacy and gather sensitive data has sparked concerns about confidentiality and consent [29]. Additionally, the deployment of drones for surveillance purposes has been associated with the normalization of ongoing subjugation and the politics of drones, raising questions about the ethical implications of their use [30]. Furthermore, ethical and sustainability aspects of civil drone use have been highlighted, emphasizing the need for systematic, structured guidance to examine and evaluate drone applications [31].

Studies on UAS Criminal Justice Curriculum

Integrating drone technology into the criminal justice curriculum presents a significant opportunity to enhance educational offerings and prepare students for the dynamic landscape of law enforcement. The potential benefits of incorporating drone technology into the curriculum include fostering spatial visualization skills and providing students with practical experience utilizing emerging technologies [32]. Integrating drone education can contribute to developing a more humanistic approach to policing, aligning with the nationwide trend toward community policing [33].

Alternative Views and Counterarguments

Drones offer innovative capabilities for law enforcement, such as enhanced population monitoring and surveillance [34]. However, existing research, including studies by [35] and [36], suggests that initiatives like Secure Communities have not consistently led to the anticipated safety outcomes. The deployment of



drones by law enforcement has also triggered counter-surveillance measures by activists, sparking debates over privacy and civil liberties concerns [36]. Moreover, the use of drones in law enforcement raises significant issues related to discrimination, surveillance practices, data security, and respect for human dignity. These challenges emphasize the need for careful consideration and the establishment of ethical guidelines in the deployment of drone technologies [37].

Summary and Knowledge Gap

The literature highlights the effectiveness of drones as tools in law enforcement, employed across various applications. Despite their efficacy, the technology is relatively new, with FAA regulations for UAS enacted in less than a decade. Consequently, a significant number of police departments do not have standardized policies or programs in place for the use of drones, primarily owing to the novelty of the technology [28]. Aside from the skills and knowledge necessary for operating drones in the national airspace, which are characterized by commercial aviators, law enforcement faces additional prerequisites and considerations [9]. Privacy concerns and fears of governmental overreach among the general public require law enforcement officers to be mindful of their public image and maintain transparency regarding drone policies, operations, and usage limits.

Moreover, constitutional considerations arise concerning how this fast-paced technology gathers evidence. Further, considerations arise concerning the storage and secure distribution of data collected by police. Overall, law enforcement must navigate these complexities to ensure responsible and effective use of drones.

Basri et al. [38] stress the importance of technology-driven education, underlining the need to integrate innovative learning tools into higher education. This emphasis aims to enhance the quality of the learning experience and adequately prepare students for the dynamic workforce ahead. Organizations frequently adopt new technologies by recruiting young technicians who possess the skills that the organization currently lacks [9]. The existing literature fails to address the specific recommendations from law enforcement agencies regarding the curriculum that should be taught to two-year college students in drone technology. This lack of information highlights the importance of directly consulting with law enforcement agencies to determine the crucial aspects of drone-related education that should be included in the curriculum for two-year college students. Clarifying these recommendations will enable educational institutions to better align their programs with the needs and expectations of law enforcement agencies, thus facilitating the development of skilled technicians equipped to meet the demands of modern law enforcement practices.

Methods

This study aims to provide law enforcement faculty members with a comprehensive set of curriculum topics and learning objectives for including drone technology in a two-year college certificate program. By equipping professors with these tools, the study aims to facilitate the development and implementation of effective drone education within law enforcement training programs.

Steps to Collect Data

The study aimed to achieve its objectives by examining the websites of police departments and county sheriff offices in six southeastern U.S. states. The email addresses were collected by visiting the websites of 2,300 police departments and sheriff's offices throughout Georgia, Virginia, North Carolina, Florida, Tennessee, and South Carolina. In instances where the email addresses for these officials were not provided, the research team sent an email to the general contact addresses requesting the contact information of the police chief or sheriff. Through this method, a list of 1,334 email addresses was created. Subsequently, an online survey was sent to these email addresses. The email text contained directions for the chief or sheriff to pass the survey along to the individual best equipped to respond to questions about their UAS program. If the agency did not have a UAS program, the email requested that the police chief or sheriff complete the survey themselves.

Survey Data Collection

The survey was executed via the online platform 'Qualtrics' and structured into three sections. The first section evaluated whether law enforcement agencies adhere to industry best practices, and the second section focused on counter-UAS operations. Both sections are directly tied to the recommendations made in the PERF report and are the focus of another publication. The third section of the survey focused on the appropriateness of various UAS in law enforcement curriculum items. The findings from this portion of the survey are the focus



of this paper. Ten questions about the general characteristics of their agency were included. The survey then presented 31 law enforcement UAS curriculum topics and asked the participants to indicate how important they were to include in a "UAS in Law Enforcement Certificate Program." The participants were given a four-point Likert scale and asked to rank their importance.

Once a draft of the survey was created, it was sent to two law enforcement officers with significant experience in UAS technology for review. Following their input, the survey was pilot-tested with 48 law enforcement offices from the email addresses collected for this study. The goal was to gauge participants' time to complete the survey and ensure it was free of any systematic issues. The data underwent analysis utilizing SPSS (Statistical Package for the Social Sciences).

Use of Artificial Intelligence

Artificial intelligence (AI) tools were employed to assist in organizing the authors' thoughts and performing initial editorial proofreading tasks in preparing this manuscript. The authors have independently verified all citations and statements of fact presented in this paper. The use of AI in this context served purely as an aid to enhance the clarity and coherence of our narrative and not as a substitute for the rigorous academic scrutiny traditionally applied in scholarly research.

Results

The survey was completed by 94 police department chiefs and county sheriffs. The distribution is shown in Table 2. Of the respondents, 83 of the surveys were completed by a representative of a police department and 11 of them from a county sheriff's office. Florida (n=20), North Carolina (n=26), and South Carolina (n=24) had the most responses, with (n=2) having notably the fewest. A one-way ANOVA statistical significance test was conducted to confirm whether the police departments and county sheriffs have any significant impact in each of the states. The result shows there was no statistical difference between the two roles.

Table 2. Survey Response Distribution

| State | Police Departments | County Sheriffs | Responses (n) |
|-------|--------------------|-----------------|---------------|
| FL | 15 | 5 | 20 (21.3%) |
| GA | 7 | 3 | 10 (10.6%) |
| NC | 21 | 5 | 26 (27.7%) |
| SC | 14 | 10 | 24 (25.5%) |
| TN | 2 | 0 | 2 (2.1%) |
| VA | 6 | 6 | 12 (12.8%) |
| Total | 65 | 29 | 94 (100.0%) |

Characteristics of Survey Participants

The survey instructed the police chiefs or sheriffs to forward the email to the most appropriate person to address questions about their agency's drone use. This study will refer to the individuals the police chiefs or sheriffs forwarded the survey to as "specialists." As shown in Table 3, the majority (88.3%) of the surveys were completed by specialists. More than half of the participants (57.4%) reported serving in suburban areas, with an additional 23.4% in rural and 19.1% in urban settings. A question was asked about the count of sworn law enforcement officials working for the agency. The responses were relatively evenly spread across the median number of approximately 100 officers. Less than half (47.9%) of the respondents indicated that their agency has a drone program. A third of the respondents' agencies had patrol officers regularly issued drones. More than 70% of respondents reported that their agencies own between 1 and 5 drones in their fleets, with a median of 5 certified pilots. Additionally, 89.4% anticipate an increase in certified pilots over the next decade. See Table 3 for a description of the agency's characteristics.



Table 3. Agencies' Characteristics

| Category | Operational Scope | Frequency | Percentage |
|--|-------------------|-----------|------------|
| Agency position | Chief/Sheriff | 11 | 11.7% |
| | Specialists | 83 | 88.3% |
| Population density | Rural | 22 | 23.4% |
| | Suburban | 54 | 57.4% |
| | Urban | 18 | 19.1% |
| Number of sworn officers at agency | 0-50 | 25 | 26.6% |
| | 51-100 | 26 | 27.7% |
| | 101-150 | 13 | 13.8% |
| | 151-200 | 8 | 8.5% |
| | 201 Above | 22 | 23.4% |
| Does the agency have a drone program? | Yes | 45 | 47.9% |
| | No | 49 | 52.1% |
| Number of certified drone pilots at agency | 0 | 7 | 7.4% |
| | 1-5 | 47 | 50.0% |
| | 6-10 | 26 | 27.7% |
| | 11-15 | 11 | 11.7% |
| | 16 Above | 3 | 3.2% |
| Do you expect the number of certified pilots to change over the next 10 years? | Yes | 84 | 89.4% |
| | No | 10 | 10.6% |
| Full-time drone unit personnel | 1-3 | 11 | 11.7% |
| | 7-9 | 1 | 2.1% |
| | 10 Above | 1 | 1.1% |
| Number of drones in agency's fleet | 1-5 | 66 | 13.8% |
| | 6-10 | 13 | 6.4% |
| | 11-15 | 6 | 6.4% |
| Does your agency regularly have patrol officers issued a drone for routine shifts? | Yes | 32 | 34% |
| | No | 62 | 66% |

Law Enforcement's Opinion on the Importance of Curriculum Topics

The law enforcement respondents were asked to rank the importance of 31 UAS curriculum topics. A four-point Likert scale was used, giving the option to rank their importance as 1) do not include, 2) somewhat important, 3) very important, and 4) must include. Participants also had the choice to select "I don't know," leading to their responses for that topic being excluded from the analysis. Table 4 outlines the mean and the standard deviation of the responses for each curriculum topic sorted by highest importance (3.6) to lowest (1.98)



Table 4. Curriculum Topics Ranking

| # | Total Mean | Stan Dev. | Item |
|----|------------|-----------|---|
| 1 | 3.6 | 0.612 | Federal and state UAS regulations |
| 2 | 3.58 | 0.647 | Basic flight skills |
| 3 | 3.41 | 0.799 | Concepts assessed with FAA Part 107 licensing exam |
| 4 | 3.36 | 0.732 | Intermediary flight skills |
| 5 | 3.32 | 0.736 | UAS search and rescue tactics and techniques |
| 6 | 3.29 | 0.831 | UAS night operations techniques |
| 7 | 3.25 | 0.834 | Ethics with UAS |
| 8 | 3.25 | 0.816 | How to request regulatory waivers from the FAA |
| 9 | 3.13 | 0.726 | Mission planning |
| 10 | 3.09 | 0.69 | UAS tactics for active shooter |
| 11 | 3.08 | 0.824 | Overwatch and command center techniques |
| 12 | 3.04 | 0.821 | Risk Management |
| 13 | 3.01 | 0.842 | Advanced flight skills |
| 14 | 2.98 | 0.888 | Aeronautical decision making |
| 15 | 2.98 | 0.786 | UAS tactics for surveillance |
| 16 | 2.82 | 0.847 | UAS tactics for crowd control |
| 17 | 2.8 | 0.776 | UAS tactics for hostage situations |
| 18 | 2.78 | 0.964 | Reading FAA sectional charts |
| 19 | 2.75 | 0.871 | How to collect thermal images from an infrared camera |
| 20 | 2.73 | 0.879 | Crew resource management |
| 21 | 2.7 | 0.844 | UAS radio communication techniques |
| 22 | 2.66 | 0.831 | Capabilities of different types of drones and manufacturers |
| 23 | 2.66 | 0.799 | Crime scene reconstruction |
| 24 | 2.63 | 0.883 | UAS tactics for bombs and explosive |
| 25 | 2.62 | 0.862 | Photography and cinematography skills |
| 26 | 2.49 | 0.896 | Traffic collision reconstruction |
| 27 | 2.38 | 0.871 | Counter UAS techniques |
| 28 | 2.18 | 0.953 | UAS tactics for prison security |
| 29 | 2.07 | 0.785 | Certification from a 3rd party validating flight skills |
| 30 | 2.06 | 0.807 | Certification from a 3rd party validating UAS management skills |
| 31 | 1.98 | 0.88 | How to create a UAS land survey |

Normality of Data Sample

Figure 1 (A) provides the Gaussian bell curve, representing a theoretical normal distribution. The figure shows a relatively small standard deviation (.437) compared to the mean (2.86), with most of the data points clustered close to the average. This suggests low variability in the data. Additionally, the data is distributed normally, meaning that around 68% of the data points are within one standard deviation of the mean.

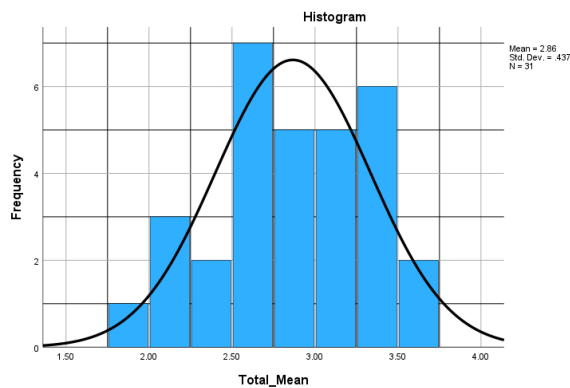
**A**

Fig. 1. (A) Gaussian Bell Curve of Mean

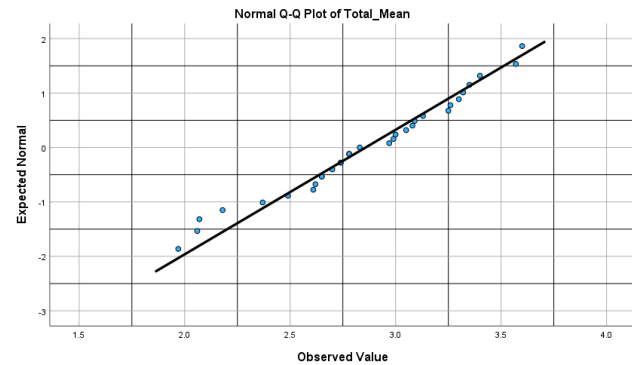
B

Fig. 1. (B) Normal Q-Q Plot of Mean

Figure 1 (B) presents a normal Q-Q (quantile-quantile) plot, showing that the data adheres to a normal distribution. This plot is used to assess how well the distribution fits the data. The data points roughly align with a straight line, which upholds the normality assumption and verifies that the data distribution conforms to the theoretical model.

The low variability around the mean implies that the mean is a good representation of the data. The Shapiro-Wilk test results and visual inspection of the curve and histogram back this conclusion. The test yielded a statistic of approximately 0.966 with a p-value of 0.426, suggesting that the distribution of mean values does not significantly deviate from normality. The means of the normal distribution indicates that the statistical premises for numerous parametric tests are met, enabling easy analysis and interpretation. This suggests that the data are consistent and reliable, ensuring that conclusions based on further statistical evaluations are well-founded.

The consistency and reliability of these statistical indicators allow for a high degree of confidence in the data set. It also suggests that any further statistical evaluations conducted using this data are likely to be accurate and reflective of the underlying phenomena being studied. The implication for our research is that the mean provides a reliable measure of central tendency suitable for further analysis and discussion concerning the broader study objectives.

Statistically Significant Differences in Curriculum Topics Based on Agency Characteristics

An essential part of the analysis was to identify if there are any statistically significant distinctions of opinion on the importance of the curriculum topics based on the characteristics of the agency shown in Table 3. The analysis of variance was conducted with SPSS statistical software, utilizing ten agency characteristics as factors concerning the thirty-one items intended for inclusion in the curriculum. Overall, there were few statistical differences based on the agency characteristics measured in this study. However, the following sections will explore the differences that were found.

Agency Position Differences in Ranking Curriculum Importance

Table 5 presents the statistically significant variable of items using the agency position as a factor. The statistically significant item measures the probability that the observed result is not attributable to chance. For this observation, aeronautical decision-making observed a statistically significant value of 0.005, and UAS night operations techniques observed a value of 0.013. The alpha level of a statistically significant variable used in this study is less than or equal to 5% (0.05). An F factor of 8.13 and 6.41 is observed. The F factor is used in the analysis of variance (ANOVA) to compare the variance between groups or to assess the overall fit of a model. A higher F value signifies a larger variance ratio within groups compared to variance between groups, indicating that the items account for a substantial part of the variance observed. The F-statistic ($F=8.13, 6.41$; $p<0.05$) signifies that the difference is statistically significant. From our study, the specialists feel that aeronautical decision-making and UAS night operations (3.09 and 3.38, respectively) are more important to be included in the UAS curriculum than what the chiefs and sheriffs believed (2.33 and 2.75, respectively). Aeronautical decision-making, or “ADM,” is a common expression in aviation and a mandatory topic in the Part 107 exam. Chiefs and Sheriffs may have undervalued the importance of this topic



due to their unfamiliarity with the phrase and its meaning. Similarly, the lack of experience with the difficulty of night operations may have caused the chiefs and sheriffs to see that as less important than the specialist.

Table 5. Statistically Significant Curriculum Items Based on Agency Position

| Factor | Item | Mean | F Factor | Significance |
|-----------------|---------------------------------|---|----------|--------------|
| Agency Position | Aeronautical Decision Making | Chief/Sheriff - 2.33 Specialist - 3.09 | 8.13 | 0.005 |
| | UAS Night Operations Techniques | Chief/Sheriff - 2.75 Specialist - 3.38 | 6.41 | 0.013 |

Other Differences in Ranking Curriculum Importance

Table 6 lists other agency characteristics with a statistically significant ranking of various curriculum items. One example includes how the participants felt about "risk management" based on the agency's number of sworn officers. Agencies with between 51 – 100 officers ranked risk management the lowest, with a score of 2.62. Large agencies with more than 200 officers ranked risk management the highest, scoring 3.41. No pattern was observed between the different groups, and no meaningful conclusions could be drawn from the findings. It was observed that agencies who issued their patrol officers drones prioritized "ethics with UAS" and "risk management" over those that did not. The items significantly differ with an F factor of 7.37 and 6.42, indicating a greater variance ratio.

Table 6. Other Differences in Ranking Curriculum Importance

| Factor | Item | Mean | F Factor | Significance |
|--|---|--|----------|--------------|
| Number of Sworn Officers at Agency | Risk Management | 0-50 (3.24) 51-100 (2.62) 101-150 (3.00) 151-200 (3.00) 200 Above (3.41) | 3.58 | 0.009 |
| Does your agency regularly have patrol officers issued a drone for routine shifts? | Ethics with UAS Risk Management | Yes (3.56) No (3.08) | 7.37 | 0.008 |
| | | Yes (3.34) No (2.90) | 6.42 | 0.013 |
| How many certified drone pilots does your agency have? | How to collect thermal images from an infrared camera | 0 (1.86) 1-5 (2.85) 6-10 (2.64) 11-15 (3.0) 16 Above (3.0) | 2.54 | 0.045 |
| | UAS tactics for crowd control | 0 (2.17) 1-5 (2.98) 6-10 (2.69) 11-15 (3.09) 16 Above (2.0) | 2.59 | 0.042 |
| Approximately how many drones under 55 pounds does your agency own? | Mission Planning | 0 (2.50) 1-5 (3.17) 6-10 (3.46) 11-15 (2.83) 16 Above (2.67) | 2.57 | 0.045 |
| | UAS night operation techniques | 0 (2.50) 1-5 (3.32) 6-10 (3.77) 11-15 (2.67) 16 Above (2.0) | 3.18 | 0.017 |



The survey asked the respondents how many certified pilots their agency had. The responses were grouped as indicated in Table 6. The mean ratings for the curriculum topics “How to collect thermal images from an infrared camera” and “UAS tactics for crowd control” were observed to be statistically different based on the number of pilots an agency had.

The survey included a question addressing how many drones the agency has. The respondents were categorized into five groups, as shown in Table 6. “Mission planning” and “UAS night Operations techniques” had mean importance rankings that were statistically significant. The mean values for each curriculum topic based on fleet size appear to have a bell-shaped distribution.

Table 6 provides the statistics of various curriculum items with statistically significant importance rankings based on agency characteristics. While this analysis was necessary, no meaningful conclusions could be drawn from any individual variance identified. The real value of this analysis was to show that no agency characteristics significantly deviated from the average rankings of the entire sample. No agency characteristic deviated from the sample mean on more than two curriculum items. As a result, the researcher feels the rankings are stable and not significantly influenced by agency size, experience, location, or population density.

Conclusion

Conclusion from Top Third Ranking of Importance

To derive actionable conclusions from our study, we analyzed responses from law enforcement officers regarding 31 proposed curriculum items for UAS integration. These items were systematically ranked from highest to lowest based on perceived importance and segmented into three groups for detailed analysis. The top tier, comprising items with an average ranking of 3.00 out of 4.00 or higher, underscores the priority areas within the law enforcement UAS curriculum.

Our findings distinctly highlight the paramount importance of regulatory knowledge. The item "Federal and state UAS regulations" emerged as the most critical, with a high ranking of 3.60, underscoring its essential role in the curriculum. Furthermore, the "concepts assessed with FAA Part 107 licensing exam" also received significant emphasis, ranking third highest at 3.41. These results demonstrate a strong consensus among the participants on the necessity for thorough regulatory training in UAS programs.

Our analysis further reveals that law enforcement officers deem operational skills in drone usage highly crucial. The survey differentiated between "basic flight skills," "intermediary flight skills," and "advanced flight skills," all of which were placed in the top third of importance rankings. Specifically, "basic flight skills" were rated highest at 3.58, followed by "intermediary flight skills" at 3.36, and "advanced flight skills" at 3.01. This pattern suggests a robust foundational curriculum demand for drone operational skills. However, the diminishing importance with increasing skill level indicates a lesser perceived return on more advanced proficiencies.

Moreover, the ability to conduct general missions effectively emerged as another pivotal training area. High rankings for curriculum items such as night missions, ethics, mission planning, risk management, and overwatch and command center operations, all scoring an average of 3.00 or above. This underscores the necessity for comprehensive mission readiness. This finding aligns with the need for robust regulatory and flight training, confirming that survey participants prioritize a curriculum that equips students with technical skills and prepares them to effectively undertake diverse operational roles.

Conclusions from Lowest Third Rankings of Importance

Three key findings surfaced from the items deemed less important in the study's survey. First, participants placed a low value on third-party certifications for verifying flight and UAS management skills, with these elements receiving some of the lowest ratings—2.07 and 2.06, respectively. This suggests a prevalent skepticism among law enforcement officers about the effectiveness of third-party certifications in demonstrating the practical skills required for UAS operations in their duties.

Furthermore, the domain of photogrammetry received low importance ratings. Despite its technical relevance, the associated skills - crime scene reconstruction, traffic collision reconstruction, and land surveying - scored between 1.98 and 2.66. This suggests that photogrammetry has less immediate applicability or perceived value in everyday law enforcement operations than in more direct drone operational skills.



Most notably, the relatively low importance assigned to counter-UAS techniques, with a ranking of 2.38, starkly contrasts with the urgency highlighted in the PERF 2020 Report. The report calls for significant actions against the threats posed by harmful drones, a sentiment that appears not to have thoroughly permeated the local law enforcement training priorities. This discrepancy suggests a gap between national security concerns and the training priorities at the regional level, indicating a need for enhanced awareness and integration of counter-UAS strategies into training curricula.

Limitations and Future Research

This investigation is subject to several constraints that merit careful consideration. First, the survey encompassed a modest cohort of 94 law enforcement officers, a sample size that may not capture the full spectrum of perspectives on drone curriculum needs. Additionally, the survey's regional focus was confined to the Southeastern United States, which may not reflect the nuances or requirements of law enforcement agencies in other areas. Moreover, relying on self-reported data could introduce a bias toward socially desirable responses rather than an unvarnished portrayal of the officers' true views. The study also did not account for the potential of on-the-job training as an alternative to formalized educational programs, which could provide significant insights into practical applications of drone technology in law enforcement. These limitations underscore the necessity for extended research in these areas to bolster the findings presented here and ensure a comprehensive understanding of the educational needs for drone technology in law enforcement.

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