TIPS, TRICKS & TECHNIQUES

A Bird's-Eye View of Using Drones in the Classroom

Samuel Naab, Emily Weigel

Abstract

Growth in the use of drones has been exponential in various fields due to their adaptable and cross-disciplinary functions. Incorporating this new technology into K–12 classrooms can be useful in engaging students and expanding their understanding of technology in the scientific workplace; however, beginners may run into challenges in designing meaningful lessons. To tackle the seemingly daunting task of using drones effectively for education, this article walks a novice instructor through various self-reflective questions in order to properly introduce a drone lesson and includes a number of resources to ensure proper safety and legal measures.

Key Words: *drones; ecology; resources; safety; technology; unmanned aerial vehicles.*

○ Introduction

Over the past fifteen years, unmanned aerial vehicles (UAVs; aka "drones") have flown their way into the spotlight as a unique technology suitable for a variety of missions and industries. Once costly and complicated devices, mass production and commercialization of drones has allowed for their integration into classroom settings. Today, a small, cost-effective drone with an eight-year average life span, such as DJI's Mavic mini (https://store.dji.com/product/mavic-mini? from=menu_products&vid=84621), can be found online with a controller, additional batteries, and a bundle of accessories for <$500. The rapid reduction in price, combined with easier pairing to existing smartphones and laptops, allows teachers to create relevant and engaging lessons in a multitude of interest areas with ease. Teachers can also expect up to eight years of use from their drones before technological updates render the devices obsolete. Not only can drones provide key data, such as aerial images, but the operation of such a device equips students with foundational knowledge of a growing industrial technology.

Drones have played a major role in biology and ecology research. Aerial photography and photogrammetry (the science of making real-world measurements from photographs) have long been employed for biodiversity research, assessment, and monitoring (Nex & Remondino, 2014). For educators, drone-based ecology, biology, and environmental lesson plans can be particularly impactful. Using one's local area as a "field site," lesson plans can include identifying local species, quantifying the percentage of surrounding greenspace, or determining suitable habitats for various animals in the area. Additionally, some drones available for purchase include features that allow students to actually construct the drone and write the necessary code for its operation, enabling the integration of mathematical formulas, such as Bernoulli's principle, as well as the fundamentals of electricity, electric motors, and battery chemistry (Schroyer, 2013).

Not only does implementing drones in the classroom expose students to real-world technologies utilized in a multitude of fields, but drones have been shown to gain and hold students' attention (Clever et al., 2016). Once their attention has been captured, students are exposed to the lesson material and key concepts, and – because of their increased enthusiasm for learning and participation in lesson plans built upon drone activity – students' incidental learning (i.e., learning achieved as the byproduct of an activity or by trial-and-error as opposed to explicit instruction) has been shown to increase with drone use (Marsick & Watkins, 2001). Not only has drone implementation been suggested to engage students uninterested in the subject matter, but the effects of incidental learning have also been shown to improve self-confidence and self-determination in students (Carnahan et al., 2016).

○ Critical Questions When Lesson Planning with Drones

Step 1 – Evaluating Current Lesson Plans

If you are thinking about incorporating a drone into a lesson, first evaluate your current lesson plans to see how a drone could enhance existing topics. What are the time parameters for incorporating a drone? If your activity is a semester-long project, such as monitoring development or growth in a local area, you will likely want to fly your drone multiple times throughout the semester to

The American Biology Teacher, Vol. 83, No. 6, pp. 407–410, ISSN 0002-7685, electronic ISSN 1938-4211. DOI: https://doi.org/10.1525/abt.2021.83.6.407.

collect long-term data and will need to account for weather changes both from day to day and seasonally in your planning. In this scenario, purchasing a drone would allow for consistent availability to gather data. If you plan on capturing images of local species and your project is completed within a day, researching local community rentals could be a cost-preventative option. These parameters can guide whether a drone purchase, rental, or loan is best, depending on when, and how long, you need the drone.

Similarly, consider the pilot(s) and the "airfield." Are your students old enough to operate the drone under supervision, or should you record your own data and present it to the class to analyze? If you live in a dense urban area (or any space with challenging geography), a more practiced pilot may be necessary to both fly and keep the drone within eyesight. Similarly, if your school is within five miles of an airport, operating your drone on school property will require specific permission from the Federal Aviation Administration (FAA). While it is a straightforward process, you may want to plan to meet or fly solo at a second location with fewer constraints.

Step 2 – Exploring Resources & Regulations

Before purchasing a drone, check in with your school's administration to see if there are any available resources, particularly funds or existing equipment elsewhere in your school or school district. Be creative – in some cases, landscaping personnel, rather than another teacher, may have access to these tools. Some local colleges and enthusiast groups may offer their equipment to instructors as a temporary loan or someone may come out to pilot with your class. With any of these options, teachers should also discuss school regulations and liability with administration.

If you intend on having student pilots, what will be your supervision and safety precautions? Will you be able to reserve a space on your campus for only your class, to ensure that no bystanders are nearby during drone operation? Are there any additional insurance liabilities that need to be explored? Should a student's parent sign a permission slip allowing them to operate a drone or be present with a student pilot? These are all discussions that you should have with your school administration to ensure the safety of your students.

Step 3 – Defining New Lesson Objectives

Consider the "value-added" aspects of a using a drone. What lesson objectives does it best support? If you are a middle school science teacher, teaching a multitude of science subjects, drone assembly could be leveraged for use in lessons on circuits and coding alongside data collection for an ecology lesson. For a high school teacher, teaching biology or earth and atmospheric sciences, drones are excellent for collection of ecological and environmental data. The unique perspective that a simple bird's-eye-view photo or video offers can provide insight into an area that can be integrated well with ideas in social studies and the creation of maps via a "shared space." With minimal planning and some postflight image processing, those same photos and videos can also be transformed into a georeferenced, spatially accurate, three-dimensional map of your field site (usable in geography courses, too). Further, these models can be used to measure specific volumes, areas, and locations of species through the real-world application of mathematics. Linking across the curriculum can not only help justify the use of drones but amplify their impact.

Step 4 – Practice

The fourth and final step to consider before incorporating a drone into your lessons is your own skill level. Before you can properly supervise students who may be piloting a drone, you should have already logged several hours to ensure your comfortability and familiarity with the control settings. If you intend to have students operate the drone, you should also perform your lessons to ensure that a novice, inexperienced pilot could execute the proper steps. Dedicating time to practice will help you safely and properly introduce your students to this emerging technology.

○ Example Lesson Plan in Brief: Measuring Ecosystem Greenspace Change over Time

Learning Objectives

Although there are many extensions to this, after doing just this basic lesson, students will be able to do the following:

1. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in a particular ecosystem.
2. Collect and evaluate their own evidence and reasoning about the effect of change on ecosystems.
3. Compare observations about human-induced environmental change to theories about community development and change succession.
4. Design systematic data collection methods and evaluate their limits.
5. Align conclusions with analyses, hypotheses, research question(s), and existing knowledge.

What Students Will Do

1. Once students arrive at the site of your study, we recommend a small tour along the borders that contain the site. The purpose of this is to (a) give the students a sense of the size of the plot, (b) point out any potential hazards along a space, and (c) orient the students so that, when they go off on their own to conduct measurements, they know how to return. Plot sizes are recommended to be no larger than a football field, and the scale should be based on how much plant life is reasonably documentable in the time allotted with the number of students in your course. The best sites are those that are near your classroom and/or that are expected to undergo rapid change soon (i.e., transitions between seasons, construction sites, etc.).
2. Students should then *explore* their site, both physically on the land and via drone images (which you may choose to take beforehand or actively alongside students; see Figure 1).
3. Students should record estimates for how much greenspace (percent greenspace) exists on the site as occupiable habitat for organisms. They can do this through gridded photos, with transects, by eye, or by another means – just so long as you can compare this to what you will capture with

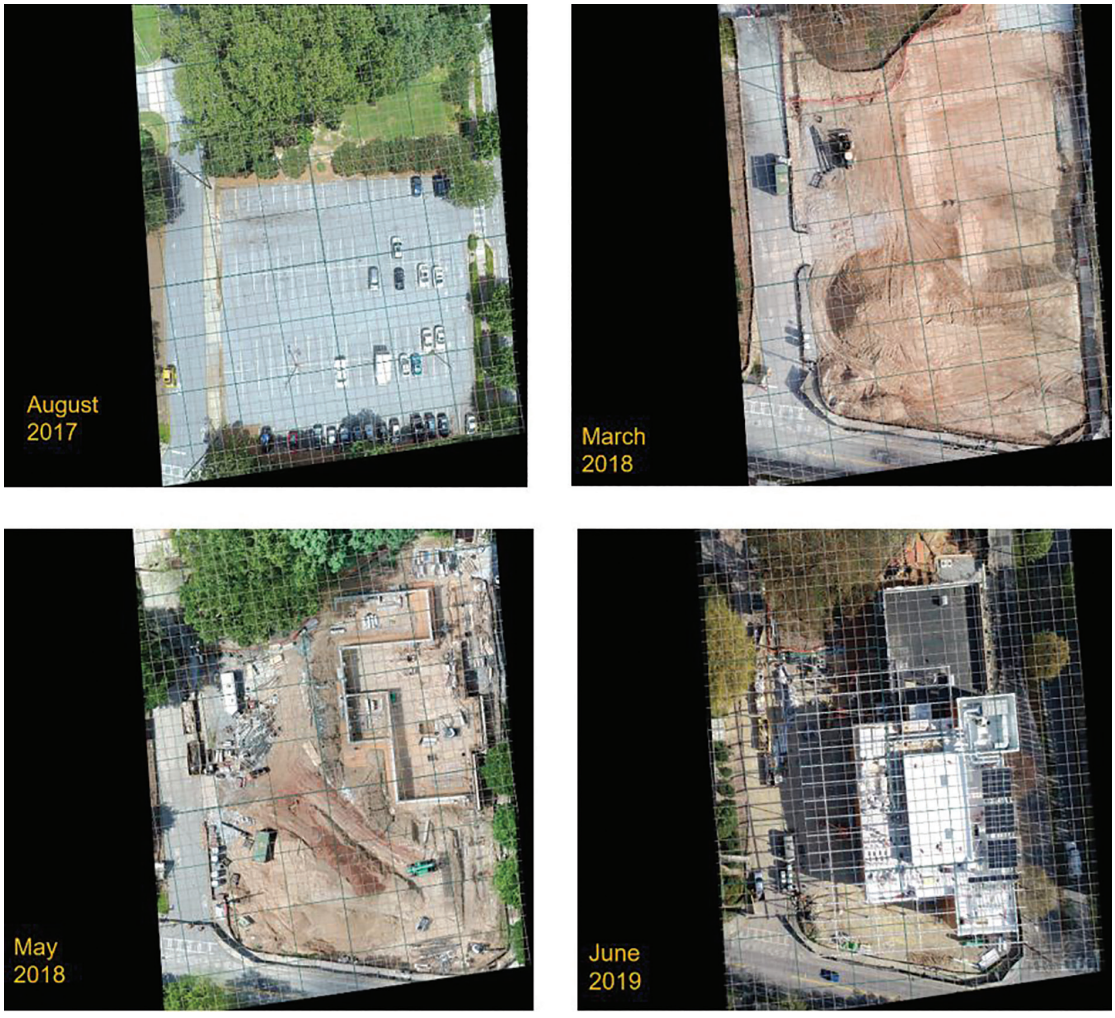

Figure 1. Drone footage taken at four timepoints from August 2017 through June 2019. Photos are taken at the same approximate height and overlaid with a grid to assist in counting and calculation of greenspace.

the drone. You may choose to bring up seasonality effects here, using historical photographs of the space or asking students to recall a familiar space in another season and estimate. This is to help *explain* their observations and offer up arguments for levels of biodiversity in the area.

4. Students should be asked to reflect on this experience and their data in order to *elaborate* on the habitats they see and the resultant biodiversity at this site. What species are most abundant? How is diversity in this space? Is it likely to change with climate, new buildings, etc.? If so, how? You may wish to incorporate iNaturalist (https://www.inaturalist.org/) observations of the site to then calculate biodiversity indices to accompany your estimates of greenspace.
5. For this exercise, a closing "What does it all mean?" discussion helps put the data collection into context. For this section, bring the groups back together to share their data with the others, to make inferences and discover patterns in the overall data. For example, frequently, the types of plants in an area are affected not only by the types of activities that take place on the site, but also by those in the surrounding habitats and how the landscaping on the site is managed. Students may discover a correlation between plant diversity and animal biodiversity, but they also may not. At the end of the project, students should be encouraged to view historical or other comparable data (when available) to posit what has already happened in this space.

Evaluation

Formative assessment can include the development and revision of hypotheses, submission of a sampling plan, the accuracy of the raw data collected, and basic calculations. Summative assessment should include "big picture" items and may involve a larger discussion/argumentative paper/report based on the data generated. The following questions may be useful for assessment:

1. Summarize the percent greenspace change data quantitatively and qualitatively.
2. What would be your hypothesis about the greenspace of this site and how it has changed over time? Does the evidence support this?

3. There are limitations on calculating greenspace, depending on method. What factors might make data collection more or less reliable, even when measuring the same area? What kinds of controls could you put in place to minimize differences in data?
4. What other types of data would you like to have to address your hypothesis for how greenspace might change over time?

Hints for Implementation/Expansion

- Incorporate drones into the project as much as possible. As the instructor, you can monitor the green space of the area over time or return to the assignment over the course of the semester to have the students make the observations themselves.
- If you are engaging older students, you can potentially have them pilot the drones as conditions allow.
- Pairing with biodiversity surveys will allow students to see how their estimates of greenspace compare to plant and animal biodiversity in a space. These can be monitored throughout the year and can be useful in having students consider the importance of replication and clear methodology in a study.
- If you so desire, in addition to measuring greenspace, IDing plants tends to go fairly quickly with the iNaturalist or Leafsnap apps. You can then further examine how greenspace is divided and used by the organisms present at a site.

○ Helpful Resources & Regulations

While nearly anyone can buy a drone, in 2016, the Federal Aviation Administration (FAA) developed a series of classifications and guidelines for the use and operation of drones, detailed in FAA Regulation Part 107. Regulations include that drones must be registered with the FAA, but drones weighing <55 pounds are eligible for automated registration (https://faadronezone.faa.gov/#/). In order to operate a drone, an individual must be 16 years of age or older and possess a remote pilot certificate (https://www.faa.gov/uas/commercial_operators/become_a_drone_pilot/) with a small UAS (Unmanned Aerial System) rating. Note that individuals lacking a certificate may also operate a drone if they are under the direct supervision of an individual who holds this remote pilot certificate. Other regulations include that a drone should never be flown near an airport, a drone may not exceed 100 mph, drones must operate under 400 feet, drones must always be flown within the line of site, and others. For more details, please visit the FAA website (https://www.faa.gov/) and read FAA Regulation Part 107.

The FAA and other organizations have created a plethora of resources to assist those looking to begin operating drones.

- The FAA B4UFLY app (https://www.faa.gov/uas/recreational_fliers/where_can_i_fly/b4ufly/) on iOS and on Android offers several features for drone pilots, including
    - letting you know if you are flying in a restricted zone,
    - assisting in planning future flights, and
    - connecting users with nearby airports.
- Know Before You Fly (http://knowbeforeyoufly.org/) is an education campaign that gives UAS operators guidance and information to help them fly safely and responsibly. The program covers recreational, commercial, and public uses.

Along with the FAA's rules and regulations regarding drones, local states and cities may possess their own regulations and requirements. Make sure you investigate your local area's policies before operation; generally, local law enforcement is a good first point of contact.

○ Conclusion

While incorporating drones into lesson plans and classroom material offers new ways to engage students and further prepare them for upcoming industry shifts, a variety of factors should be considered before purchasing or renting a drone. Personal research on what drone and lesson plans will most apply to your classroom is a necessity prior to purchasing a drone. Edventures (https://edventures.com/) is one of many platforms that offer a directory for teachers to compare various drones and their applications (you can access their comparison charts for indoor and outdoor drones at https://edventures.com/blogs/edu-drones-101/the-best-drone-for-stem-education).

Drones are a technology not of the future, but of the here-and-now. We hope you will use the tips above to engage your students in drone-assisted lessons and reach new heights in learning.

References

Carnahan, C., Zieger, L. & Crowley, K. (2016). Drones in education: let your students' imaginations soar. Eugene, OR: International Society for Technology in Education.

Clever, H., Brown, A. & Kapila, V. (2016). Using an AR Drone Lab in a Secondary Education Classroom to Promote Quantitative Research. 2016 ASEE Annual Conference & Exposition Proceedings.

Marsick, V.J. & Watkins, K.E. (2001). Informal and incidental learning. *New Directions for Adult and Continuing Education, 2001* (89), 25–34.

Nex, F. & Remondino, F. (2014). UAV for 3D mapping applications: a review. *Applied Geomatics, 6*(1), 1–15.

Schroyer, M. (2013). Drones for schools. https://robohub.org/drones-for-schools/.

SAMUEL NAAB (snaab21@gatech.edu) is a 2021 graduate of the School of Literature, Media, and Communication, and EMILY WEIGEL (emily.weigel@biosci.gatech.edu) is a Senior Academic Professional in the School of Biological Sciences, both at the Georgia Institute of Technology, Atlanta, GA 30313.