Elevating Education: The Impact of Drones on 21st Century Learning

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Abstract

This unit is entitled "Elevating Education: The Impact of Drones on 21st Century Learning." It stresses the need for STEM education to become more relevant to the technological advances of this century and to focus more on preparing our students to access the careers of today and tomorrow. It suggests that using drones in the classroom would engage students in a unique way and motivate them to become better critical thinkers and problem-solvers. Students will apply the coding skills they are already learning to program and fly drones, learn about drone safety, research current applications for drones and explore other ways they can be used to solve problems, research careers using drones and determine beginning salaries, and create two Google Slides presentations and one Google Site to showcase their findings. This unit will be suitable for use in middle school STEM, Digital Literacy, or ELA classroom.

Keywords: Drones, drone applications, drone careers, STEM, middle school, Digital Literacy, research, ELA, Google Sites, Google Slides, coding, SCRATCH, DroneBlocks, CoDrone EDU, DJI Tello drones

Unit Content

Introduction

Teaching students in the 21st century has never been more challenging and exciting! Educators have always tackled the responsibility of preparing their students for the future, but never during a time when new innovations are being developed, seemingly at the speed of light, and when the technologies to create and access these innovations have far exceeded anything we were ever taught in school. Part of the challenge, then, is keeping up with these technologies as educators so that we can then provide the tools to our students to prepare them for careers that do not even exist yet, while fully embracing the reality that many of the traditional careers that the educational system prepares students for may become obsolete by the time they graduate from high school.

A second layer of the challenge is providing student access to these cutting-edge technologies in an urban school setting. Urban schools are often underfunded, understaffed, and unsafe, with classes that are over-sized, lacking current and relevant educational materials and basic technology for all students. This amplifies and multiplies the challenge of providing equitable, rigorous education to all students. Our students are lacking so many of the basic skills that it is sometimes difficult to imagine how we are to

get them where they need to go. I am learning that sometimes all we need to do is plant a seed or ignite a spark and point them in the right direction. This is encouraging to me because I realize that I do not have to know everything, but I can nurture the natural curiosity in my students. Sometimes we just have to open the door, point the way, and our students will run through on their own. I choose not to use my lack of knowledge as an excuse not to make new technologies available to my students. At the very least, I want to whet their appetites to the possibilities and accelerate their desire to learn more on their own. There is a plethora of resources available to educators to introduce new material in fun and exciting ways, but we have to be willing to be stretched in the same ways that we hope to stretch our students and widen their horizons.

So, why use drones in the classroom? There are so many new applications for drones in the real world that it is exciting to explore the different ways that drones are being used to solve problems and make positive and lasting differences in the world. Exploring these new applications can open the door to new careers, including those that do not yet exist. One thing that I learned in a bioengineering course I took at Yale is that when I learn to apply the principles of design thinking to solve problems, I don't have to know exactly how to create the design. I just have to be able to pitch the idea to someone who knows how to build the thing, such as in app design, or be able to suggest a different application for something that has already been created. Using drones in the classroom can help students begin to think about different ways to solve real world problems.

Another reason to use drones in the classroom is to take the coding skills my students are already learning and apply them to manipulating and maneuvering a drone in the real world, not just on a computer screen. This will provide my students with hands-on opportunities to learn computer programming basics in SCRATCH and use a new technology to demonstrate what they have created. They will learn how to work cooperatively and when they can begin to see the connections between what they are learning in digital literacy and in their math and science classes, their learning will begin to increase exponentially.

Probably one of the most compelling reasons to use drones in the classroom is that students learn more when they are playing and having fun. Most times they won't even realize that they are learning as well. Students who may be unwilling to learn coding for the sake of learning coding or participate in cooperative groups may be much more engaged in the process when they realize that they can control a drone with the commands they have created. As the content becomes more challenging, teachers still need to find creative and engaging ways to keep our kids learning. I believe using drones is one way we can engage our students and expose them to so many new possibilities for their futures.

Introduction—Why Use Drones in Education?

The emerging drone industry is projected to become a multibillion-dollar industry across the private, civil, and government sectors within the next few years. These sectors include, but are not limited to technology, information technology (IT), construction, engineering, agriculture, ecology, health, mining, cybersecurity, military, transportation, and the arts and entertainment industries. [1] Drones (sometimes called unmanned aerial vehicles or UAVs) are increasingly being used in ways that were unheard of and not even considered only a few years ago. While some may view drones as simply remote-controlled toys, the practical applications for and the emerging careers that use drones require that students be prepared to compete in these job markets.

Additionally, the need for those who can design, build, fly, and repair drones will be in high demand, yet the average high school student in the United States is ill-equipped with the training necessary to pursue these careers. "The decline of students completing science, technology, engineering, and mathematics (STEM) majors has been traced to high school STEM programs ineffectively preparing students with the level of problem-solving skills needed for college-level coursework." [2] As the number of trained professionals in STEM careers in the United States continues to fall short of demand, there is an increasing need for educators to prepare our students to meet this demand.

Although the number of careers calling for training and knowledge of STEM topics continue to grow, the presence of STEM education in K-12 is lacking. Therefore, there is a need to broaden the presence of STEM in current curricula. There is also a need for tools and guidelines to help educators in teaching STEM courses. Such tools should engage students in the subject and encourage them to pursue further education and careers in the field. Drones naturally spark students' interest, making it easier to engage them in the classroom. Additionally, they can be used to teach a broad spectrum of STEM courses and they allow students to get both hardware and software experience. [3]

Using drones in the classroom addresses the need for more engaging and cutting-edge STEM education, not just at the middle school and high school levels, but even in elementary classrooms. Students need to learn more problem-solving skills and using drones provides a hand-on approach to learning to code. Educators who extend their

[1] Bhuyan, J., Wu, F., Thomas, C. *et al.* Aerial Drone: an Effective Tool to Teach Information Technology and Cybersecurity through Project Based Learning to Minority High School Students in the U.S. *TechTrends* **64**, 899–910 (2020).

[2] V. Farr and G. Light, "Integrated STEM Helps Drone Education Fly," 2019 IEEE Integrated STEM Education Conference (ISEC), Princeton, NJ, USA, 2019, pp. 398-401, doi: 10.1109/ISECon.2019.8881958

[3] Tezza, D., Garcia, S., Andujar, M. (2020). Let's Learn! An Initial Guide on Using Drones to Teach STEM for Children. In: Zaphiris, P., Ioannou, A. (eds) Learning and Collaboration Technologies. Human and Technology Ecosystems. HCII 2020. Lecture Notes in Computer Science), vol 12206. Springer, Cham.

lessons to drone building and programming prepare students for real world careers that can utilize those skills in practical ways.

Drones have grown in popularity over the past few years and their use is expected to continue to increase. One of my personal interests is the use of drones in photography, but other applications include racing, filmmaking, precision agriculture, etc. Drones have been a topic of focus for many researchers. An emerging trend is the use of drones in the education realm to teach STEM for young students (e.g. K-12). General robotics has been integrated in classrooms to spark students' interest in STEM, starting in kindergarten and elementary school. Drones are highly engaging, and they inspire students to engage in critical thinking and become problem solvers.[4]

"Studies have shown that teaching STEM for young students provides several benefits, such as increasing their ability to solve problems, innovate, and perform logical thinking. Additionally, introducing STEM at an early age can motivate students to pursue a career in STEM-related fields, and help avoid stereotypes and other impediments to becoming innovators in the future. Studies have also shown that teaching math and science improves students' attitude and interest in school and motivates their learning experience."[5]

Teaching robotics can be a powerful tool for teaching non-technical subjects (e.g. language and music, technical fields (e.g. robotics and programming), and as well as general STEM related topics. It has been shown that its use can improve critical thinking and problem-solving skills, as well as improving students' motivation, engagement, and attitude. In the STEM education realm, robotic-based learning provides at least five advantages over a traditional approach: (1) in integrates STEM topics in a multidisciplinary fashion, (2) it transforms abstract concepts into concrete learning, (3) it combines STEM theory with practice, (4) it provides a hands-on experience that it is active and engaging, (5) it provides an enjoyable and motivating learning environment. A challenge in using robotics for learning is the need for new technologies that are affordable and designed specifically developed for young learners.[6] Educators need to empower students to use emerging digital technologies to investigate various aspects of learning problems. Drones as one of digital smart technologies provided a valuable learning opportunity that enabled young kids to become innovative designers

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[4] Tezza, D., Garcia, S., Andujar, M. (2020)
[5] Tezza, D., Garcia, S., Andujar, M. (2020)

[6] Tezza, D., Garcia, S., Andujar, M. (2020)

(programming design) and computational thinkers (computing experience) for the future society.[7]

In addition to learning the many applications of drones and how to fly drones, students must also learn drone safety and drone ethics. SOAR (safety, operation, active learning, and research) is a four-axis model proposed by Carnahan et al. (2016) for the successful integration of drones in teaching. Each of the above axes focuses on a different aspect: the first covers safety and legal issues, the second involves handling/operational issues, the third relates to teaching, and the fourth involves the research that should be done on this issue.[8]

Drones can also be used to teach the fundamentals of programming, providing the benefit that students can see their code controlling an actual physical system. For instance, a beginner programming student is more likely to be impressed and engaged in the activity when a drone is taking-off and landing rather than simply seeing a print statement on the screen (e.g. hello world code). [9] There is a wide variety of drones that can be used in the classroom such as CoDrone Edu and DJI Tello drones. They can be flown with controllers, but educators can use them to teach students to program them using a block code language such as SCRATCH. More advanced students can learn to program using PYTHON, C, or JAVA.

Computer programming can help students develop sequencing skills. Students engaged in programming must arrange symbolic commands in sequence to design the desired actions. The visual block programming languages (e.g., SCRATCH) commonly used in elementary schools also require children to sequence various color-based blocks to perform animation tasks.

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

[7] Chou, Pao-Nan. 2018. "Smart Technology for Sustainable Curriculum: Using Drone to Support Young Students' Learning" *Sustainability* 10, no. 10: 3819. https://doi.org/10.3390/su10103819

[8] Voštinár, P., Horváthová, D., Klimová, N. (2018). The Programmable Drone for STEM Education. In: Clua, E., Roque, L., Lugmayr, A., Tuomi, P. (eds) Entertainment Computing – ICEC 2018. ICEC 2018. Lecture Notes in Computer Science(), vol 11112. Springer, Cham. https://doi-org.proxy.library.upenn.edu/10.1007/978-3-319-99426-0_18

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

9 Tezza, D., Garcia, S., Andujar, M. (2020)

and hold students' attention. [10] 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, student incidental learning occurs. Incidental learning is a byproduct of hands-on activities where students learn by doing, making mistakes, and trying again. Drone implementation can engage students uninterested in the subject matter and has been shown to improve self-confidence and self-determination in students.[11]

This curriculum unit has been created to address these challenges in ways that will engage and motivate our students, especially our African American and female students, to learn in creative ways while preparing them to access lucrative careers in STEM fields. It specifically uses drones in the classroom to achieve that end by allowing students explore cutting-edge ways drones are being used today and may be used in the future to solve problems.

Topics that will be addressed in this unit include the following:

a) What are drones? Are they more than just a toy?
b) How are drones being used to solve problems?
c) Preparing students for careers that use drones.
d) Using drones responsibly and ethically
e) Let's get coding so we can start flying!
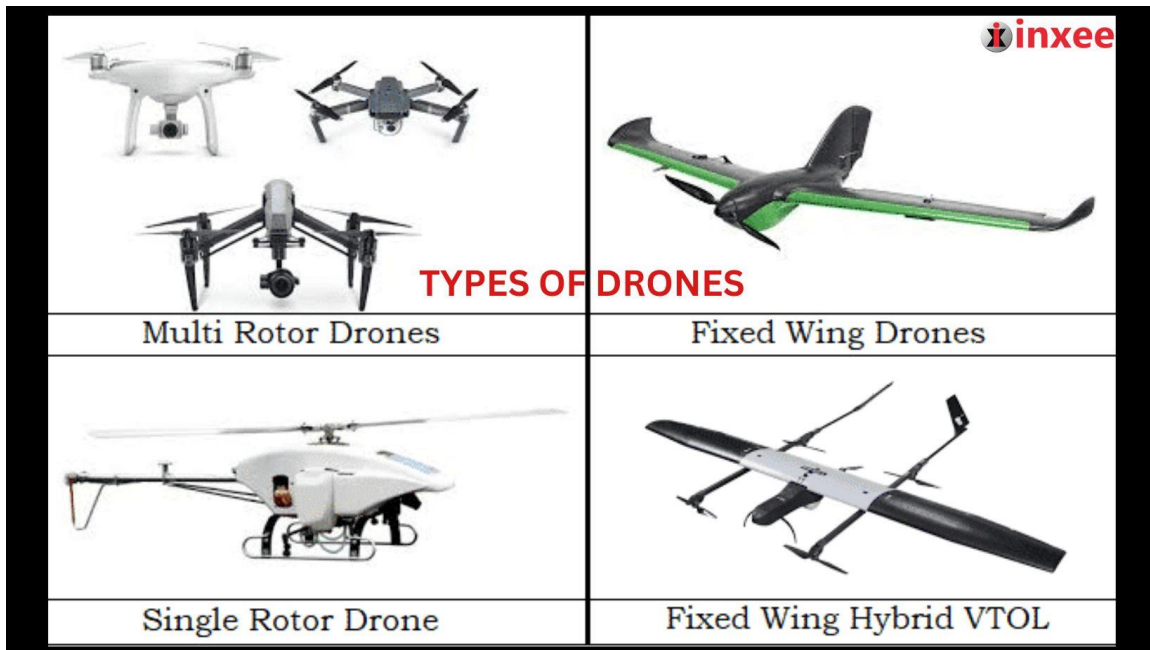
What Are Drones?

A drone is any type of unmanned aerial vehicle (UAV), that is an aircraft that is flown without a pilot inside. They are sometimes referred to as unmanned aerial systems (UAS) which comprises a UAV plus a ground station and data links. They can be remotely piloted or programmed to fly autonomously.

There are many different types of drones. A drone can have a single rotor or have multiple rotors, can have fixed wings, or be a hybrid of the two. The drones recommended for this unit are quadrotors (CoDrone EDU and DJI Tello drones).

Figure 1

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[10] 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.

[11] Carnahan, C., Zieger, L. & Crowley, K. (2016).

Source: https://inxee.com/blog/types-of-drones/

How are Drones Being Used to Solve Problems?

Drones have gained popularity over the years as a child's toy or something to be used for strictly recreational use by a hobbyist, but drones are far more valuable than one may think. There are many practical applications for drones today and there will continue to be new applications for drones in the future.

Health

Drones can be used in the healthcare field in many ways. "Unmanned aerial vehicles, or drones, are one example of technology that can have a multitude of public health applications including supply chain support (e.g., transport of medications, vaccines, biological samples), emergency response (e.g., transport of blood and plasma), disease prevention (e.g., sterile mosquito release for vector control), deployment of networks for data harvesting in unconnected areas, and health research."[12]

Agriculture

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[12] Knoblauch AM, de la Rosa S, Sherman J*, et al.* Bi-directional drones to strengthen healthcare provision: experiences and lessons from Madagascar, Malawi and Senegal. *BMJ Global Health* 2019;**4:**e001541.

Drones are being used in agriculture to increase production of healthier food, decrease production costs, and the development of precise farming. There have even been reports of farmers using drones to find lost livestock. The cameras and sensors on drones are important in helping farmers to determine the health of their crops, to assess the need for better irrigation or drainage, to classify plants, to monitor the growth of weeds, and to locate fires.[13] Drones can also be used to spray or dust crops with pesticides or water, and ultimately, they can same time by completing tasks that were often time-consuming or impossible to complete.

Mining

Drones have proven to be invaluable in mining operations. They can safely navigate terrain that humans are unable to explore without threat to their lives. The main uses of drones in mining include:

1. Monitoring, surveillance, and inspection
2. Mining exploration
3. Topography and mapping
4. Storage and warehousing
5. Hauling road management and optimization
6. Monitoring settling dams
7. Hydrological and sediments monitoring [14]

Disaster Response

Along the very same lines as using drones in mining operations is the use of drones in search and rescue operations during natural disasters and in wars. Drones can improve the response time of rescue teams and navigate terrain that is unsafe for humans. One group of researchers has proposed the use of swarms of drones in search and rescue so that if one drone becomes incapacitated a partner drone can take over and help that drone get back home.[15] This is an interesting proposal because the use of drones would serve a

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[13] Spalevic, Zaklina, Milos Ilic, and Vladimir Savija. "THE USE OF DRONES IN AGRICULTURE - ICT POLICY, LEGAL AND ECONOMICAL ASPECTS." *Ekonomika* 64, no. 4 (Oct, 2018): 93-107.

[14] Vangu, Gheorghe Marian. "The Use of Drones in Mining Operations." *Revista minelor.* 28.3 (2022): 73–82. Web.

[15] M. M. Z. Shaheen, H. H. Amer and N. A. Ali, "Robust Air-to-Air Channel Model for Swarms of Drones in Search and Rescue Missions," in IEEE Access, vol. 11, pp. 68890-68896, 2023, doi: 10.1109/ACCESS.2023.3292517.

double purpose—the saving of human life and the recovering of damaged drones that would otherwise be lost.

Construction/Inspections

In the construction industry, drones provide easy access to large or hard-to-reach facilities, as well as to complex or high-rise facilities. They can provide aerial photography data, map information, and images used for:

- Land surveying
- Building inspections
- Providing visual materials to customers and employees
- Monitoring the progress of work on the construction site
- Security control
- Mappings [16]

Arts and Entertainment

One of the most popular and familiar uses for drones is in the arts and entertainment industry. Many people have seen drone shows and one would be hard-pressed to find videos online that were not captured by drone photography. Drones have been used in filmmaking, capturing footage at weddings, sporting events, and other special events.

Military

The use of drones in the military has revolutionized remote warfare. With that said, it is somewhat disturbing that humans continue to find more and more efficient ways of taking human lives without the loss of life on their side. The potential for collateral damage is great when using drones as with any other weapons of warfare. Some of the ways the military is using drones includes the following:

1. Training and Simulation
2. Electronic Warfare
3. Surveillance and Reconnaissance
4. Target Acquisition
5. Strikes and Attacks

[16] Zaychenko, Irina, Anna Smirnova, and Alexandra Borremans. 2018. "Digital Transformation: The Case of the Application of Drones in Construction." *MATEC Web of Conferences* 193: 5066.

6. Mine Detection
7. Search and Rescue
8. Border and Maritime Patrol
9. Logistics and Supply
10. Communication Relay

Cybersecurity

The use of drones in cybersecurity raises several privacy and security issues. Some of these issues include communication-based attacks, on sensors, on hardware, hardware-based attacks, software attacks, and physical attacks on the drone itself. Other non-cybersecurity challenges of drones include terrorism, mid-air collisions, illegal surveillance, smuggling, electronic snooping, and reconnaissance, as well as cyber-attacks, such as hacking, jamming, spoofing, electronic snooping, eavesdropping, advanced persistent threat (APT), reconnaissance, hijacking, man-in-the-middle attacks. [17] This creates the need for ethical considerations in the use of drones in cybersecurity.

Education

Finally, this entire unit is dedicated to the use of drones in education. Not only do students need to be made aware of the many industries that use drones in their daily operations and the careers that are available to them, but there are many other practical skills that they can learn from being able to program and fly them themselves.

Preparing Students for Careers that Use Drones

There is a great demand for those who can program, design, build, and fly drones in order to meet the demand in today's emerging careers using drones. There are three basic components necessary to prepare students for careers using drones. Although the paper researched looks at designing a program for undergraduate students, any exposure to and experience with these components prior to college would certainly give our students a head start in preparing. I have heard of high school programs that prepare students in at least one of the components: 1) Drone programming using Python, 2) designing and fabricating drones using Computer-Aided Design (CAD) and rapid prototyping, and 3)

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[17] Omolara, A.E., Alawida, M. & Abiodun, O.I. Drone cybersecurity issues, solutions, trend insights and future perspectives: a survey. *Neural Comput & Applic* **35**, 23063–23101 (2023). https://doi-org.proxy.library.upenn.edu/10.1007/s00521-023-08857-7

the US Federal Aviation Administration (FAA) Part 107 Commercial small Unmanned Aerial Vehicles (sUAVs) pilot test. [18]

In addition to learning how to prepare for careers using drones, students need to be made aware of what types of careers exist, both current and emerging, where a knowledge of how to program, design, build, and especially fly drones would be extremely valuable. One of the activities for this unit will require students to research careers they may be interested in and determine what the starting salary is for those careers. They will use Figure 2 below as a starting place, and perhaps the starting salaries will serve as a motivation to buckle down and learn the skills necessary to reach those aspirations.

Figure 2: Careers Using Drones

CAREERS USING DRONES
Drone Operator/Pilot: Responsible for flying and operating drones for various purposes, such as aerial photography, surveying, or inspections. Pilots may need to obtain certifications depending on local regulations.
Aerial Photographer/Videographer: Uses drones to capture aerial images and videos for a variety of purposes, including filmmaking, real estate, and advertising.
Surveyor: Utilizes drones for land surveying and mapping. Drones can quickly and accurately collect data for construction projects, urban planning, and environmental assessments.
Infrastructure Inspector: Inspects infrastructure such as bridges, power lines, and pipelines using drones to assess maintenance needs, identify issues, and ensure structural integrity.
Film and Media Production:

[18] D. Lobo, D. Patel, J. Morainvile, P. Shekhar and P. Abichandani, "Preparing Students for Drone Careers Using Active Learning Instruction," in IEEE Access, vol. 9, pp. 126216-126230, 2021, doi: 10.1109/ACCESS.2021.3110578.

Drone pilots and operators are employed in the film and media industry to capture dynamic aerial shots and footage for movies, documentaries, and commercials.

Search and Rescue Specialist:

Deploys drones in search and rescue operations to locate missing persons or assess disaster-stricken areas quickly and efficiently.

Insurance Adjuster:

Uses drones to assess damage and gather information for insurance claims, particularly in cases of natural disasters or accidents.

Precision Agriculture Specialist:

Implements drones for precision agriculture by collecting data on crop health, soil conditions, and overall farm management. This helps optimize crop yields and resource usage.

Emergency Response Coordinator:

Coordinates the deployment of drones in emergency situations, such as natural disasters, to gather real-time information and assist in decision-making.

Mining Engineer:

Uses drones to survey mining sites, monitor extraction processes, and assess environmental impact. Drones enhance efficiency and safety in the mining industry.

Construction Project Manager:

Incorporates drones for project monitoring, surveying, and site analysis in construction projects. This helps improve project planning and execution.

Environmental Conservationist:

Applies drones to monitor and survey ecosystems, wildlife, and environmental changes. Drones are used in conservation efforts to track animal populations and assess the impact of climate change.

Defense and Military Roles:

In military and defense sectors, professionals may operate drones for surveillance, reconnaissance, and even in combat situations.
GIS (Geographic Information System) Analyst: Integrates drone data into GIS to create detailed maps and spatial analyses. This is valuable in urban planning, resource management, and environmental monitoring.
Education and Training Specialist: Develops and delivers training programs for individuals looking to become certified drone pilots or operators.

Using Drones Ethically and Responsibly

Although this unit will address using drones indoors in the classroom, it is important to understand the rules for flying drones outside. First of all, any drone weighing 250g (.55lb) or more will need to be registered with the FAA. Additionally, in order to fly a drone for any reason other than strictly recreational use will require the Part 107 FAA certification for drone pilots. Recreational pilots will need to take The Recreational UAS Safety Test (TRUST) and carry their certificate card each time they fly their drone.[19]

The nine requirements to fly recreationally under USC 44809:

1. Fly only for recreational purposes (enjoyment).

2. Follow the safety guidelines of an FAA-recognized Community Based Organization (CBO).

3. Keep your drone within the visual line of sight or use a visual observer who is co-located (physically next to) and in direct communication with you.

4. Give way to and do not interfere with manned aircraft.

5. Fly at or below 400 feet in controlled airspace (Class B, C, D, and E) only with prior authorization by using LAANC or DroneZone.

6. Fly at or below 400 feet in Class G (uncontrolled) airspace.

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[19] https://www.faa.gov/uas/getting_started

7. Take The Recreational UAS Safety Test (TRUST) and carry proof of test passage.

8. Have a current registration, mark your drones on the outside with the registration number and carry proof of registration with you.

9. Do not operate your drone in a dangerous manner. For example: a. Do not interfere with emergency response or law enforcement activities. b. Do not fly under the influence of drugs or alcohol.[20]

     When using drones in the classroom, students should always wear safety goggles, tie back hair, not fly near other students, not fly too high, and have another student as a spotter to be another set of eyes. Teachers may also consider having parents sign a waiver that acknowledges that there are some risks involved in operating drones and have students sign that they will operate them responsibly.

     There are other ethical considerations when flying drones outside, such as privacy issues, surveillance and civil liberties, data security and hacking, weaponization and use in armed conflict, safety concerns, autonomous drones and AI, ethical use in law enforcement, and many more. As with any new technologies, there may be implications that may arise that have not been considered previously and laws to govern these situations may not even exist yet. These would be great topics for debate in a high school classroom in order to get students thinking about how, when, and where drones could be used ethically and responsibly.

Let's Get Coding So We Can Start Flying!

As stated earlier, this unit will use both the CoDrone EDU and DJI Tello drones for the coding and drone flying portion of the lessons. My students have been learning the block coding language SCRATCH, so they should have no difficulty using BLOCKLY or DroneBlocks to program their drones using their Chromebooks.

(Note: One of the ways I have acquired my drones is through DonorsChoose. I created projects requesting DJI Tello drones which I found on Amazon. I have also purchased them second-hand at huge discounts on sites like eBay and Mercari, so there are options for acquiring them reasonably priced, even if you do not have a budget for them.)

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[20] **What are the Rules to Fly Your Drone in 2023?**
https://youtu.be/oyE2x9B0CVA?si=M7IogCnAOgtb2bRe)

Teaching Strategies

Read-Aloud: *Drones, Drones, Everywhere!* **by Ashlee Cooper**

(Source: Amazon)

Teacher will introduce the topic of drones by reading aloud to the class, *Drones, Drones, Everywhere!* by Ashlee Cooper and Faye Paige Edwards. Ashlee Cooper is the founder and CEO of Droneversity and is a FAA Part 107 Drone Pilot. Although the book is written for younger children, the book is full of beautiful illustrations with children of color, catchy rhymes, and basically teaches a mini course on drones and drone safety. The main character is Savannah, who is a young drone pilot and teaches all her friends about flying drones. Teacher will also include a video of the real Savannah giving a drone demonstration from the Droneversity website.

(Video Source: https://www.droneversity.org/youth)

Types of <u>Drones</u> **(Handout)**

Students will learn about the different types of drones and learn how to identify them visually based on the number of rotors. Some will be fixed wing drones, similar to airplanes, and others will be a hybrid combination of both rotors/propellers and a fixed wing style. Students will view a worksheet identifying several types of drones. Then they will complete a quiz on the types of drones.

Name These Types of Drones <u>Quiz</u>

Drone Safety (Handout and Quiz)

Using the student-friendly safety rules at the back of the *Drones, Drones, Everywhere* book and the rules included in the content section of this unit, students will need to demonstrate that they know and can follow drone safety rules before they can fly a drone in the classroom. Teacher will teach the rules using a worksheet and YouTube videos before giving a quiz.

Drone <u>Safety</u> Handout

Drone Safety Quiz

Research

Students will conduct research on drone applications and drone careers. They will gather information in small groups about how drones are used to solve real-world problems. They will also research careers that use drones and include starting salaries for those careers. Their research will include text and images with source citations to be used on three additional projects.

Research Rubric (assignment)

Google Slides Presentation

Each group will complete 2 Google slides presentations using the information they have gathered through their research. One presentation will be about drone applications and the other will be about careers using drones. Both presentations will include text and images, themes and backgrounds, and animations and transitions. For any students not knowing how to create a Google Slides presentation, they may refer to Applied Digital Skills, "All About a Topic," which has step-by-step video instruction on how to complete a Google Slides presentation with all the elements required above. Applied Digital Skills is a free program that I use with all my students.

Create a Presentation "All About a Topic"

Google Sites

Students will then compile everything they have learned thus far to create a Google Site displaying their knowledge and digital literacy skills. They will include both of their Google slides presentations, as well as any other information and images they choose to add about drones. This is the project where they will showcase the work they have done before beginning the hands-on activities. If students are unfamiliar with creating a Google Site, they can use Applied Digital Skills for this project as well.

Design a Website to Promote a Project

Drone Programming

If students are using the CoDrone EDU, they will use Blockly to program their drone to perform simple maneuvers. If they are using DJI Tello drones, they will use DroneBlocks, which is basically SCRATCH. Students will program their drones to take off and land, roll, pitch, yaw, throttle, etc.

Drone YouTube Tutorials

Students will have access to a multitude of drone tutorials to practice coding and learning drone terminology, drone maneuvers, drone safety, etc.

Drone Competition (Optional)

This could be as simple as creating an obstacle course to fly the drones through and/or having the students compete in completing basic maneuvers in a certain amount of time.

Classroom Activities

Lesson 1: "Drone Basics and Safety" (2-3 days)

Objectives:

- Students will identify 4 main categories of drones, and several subcategories of drones.
- Students will learn and demonstrate 9 rules of safety when flying a drone recreationally.

Standards:

WHST.6-8.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ETS1-2)
WHST.6-8.8	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.(MS-ETS1-1)

Materials Needed:

- Book- *Drones*, *Drones*, *Everywhere!* by Ashlee Cooper
- Video Clip of Savannah Flying a Drone: https://www.droneversity.org/youth
- Drones Handout/Drones Quiz
- Drone Safety Handout/Drone Safety Quiz
- Computer/Chromebooks

Essential Questions:

- What are drones? How can we use drones safely in the classroom to learn?

Activities**:**

Introduction: Do you know what a drone is? Has anyone ever flown or   programmed a drone? Does anyone know of any ways drones are used to solve problems?

Teacher Read-Aloud: *Drones, Drones, Everywhere!* Allow students to share what they notice about the illustrations. Read through the special resources at the back of the book, including the vocabulary, drone safety area, and question and answers. Ask students to respond to questions to check their understanding of what was read to them.

Video Clip: Show Video Clip of Savannah Flying a Drone. Point out the fact that this is the real Savannah that the book is about. https://www.droneversity.org/youth

Types of Drones Handout—Teacher will review the types of drones on the handout.

Google Search and Worksheet: Students will work with a partner to find images of drones that fall into the four major categories of drones: **single rotor**, **multirotor**, **fixed wings**, and **hybrid**. Students will then create a worksheet in Google Docs with one image of each of the four categories of drones.

Drones Quiz: Students will take the quiz at the end of Day 1 or at the beginning of Day 2 of Lesson 1 after a brief review.

Video Clip #1: "**Drone Safety (Canada) (For Students)" (2:24)**

Video Clip #2: **What are the Rules to Fly Your Drone in 2023 (18:50)**

Drone Safety Handout: Teacher will review the drone safety handout with the students. They should be making notations on their handouts as they watch the videos because the information will be the same.

Drone Safety Quiz: Students will take this quiz at the end of Lesson 1.

TRUST Exam   Students will take the TRUST exam in order to earn their certificate to fly drones recreationally. They will take it until they pass. It is a free test.

Closing: What new knowledge have you learned today? Are you interested in learning to program and fly a drone? Allow students to share out freely.

Lesson 2: "Drone Applications and Careers" (7 days)

Objectives:

- Students will work in groups to research 10 applications for drones, including text, images, and source citations.
- Students will work in groups to research 10 careers using drones and their salaries, including text, images, and source citations.
- Students will create a Google Slides presentation to share research about drone applications.
- Students will create a Google Slide presentation to share research about careers using drones.
- Students will compile all information learned thus far into a Google Site.

Standards:

ISTE Standard 3 Knowledge Constructor: Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others.

WHST.6-8.8	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.(MS-ETS1-1)
WHST.6-8.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ETS1-2)

15.4.8.G: Create an advanced digital project using appropriate software/application for an authentic task.
15.4.8.K. Create a multimedia project using student created digital media.15.6.8.L. Evaluate the accuracy and bias of online sources of information; appropriately cite online resources.

15.6.8.M. Explore and describe how emerging technologies are used across different career paths.

Materials Needed:

- Computer/Chromebooks
- **Create a Presentation "All About a Topic" in Google Slides**
- **Design a Website to Promote a Project**
- **Research Rubric**

- **Slides Presentation Rubric and Scoring Guidelines**
- **Google Site Rubric and Scoring Guidelines**

Essential Questions:

- How can drones be used to solve problems?
- What are some careers that use drones?
- How can you use Google Sites to showcase your research?

Activities:

1. (3 days) Students will form groups of four students to work cooperatively throughout Lesson 2. Each member of the group will share in the completion of the overall task. Two students will research drone applications and create a Google Slides presentation. The other two will research drone careers and create a Google Slides presentation. Students will follow the guidelines spelled out on the rubric, making sure that they include source citations for everything. Students may refer to the Applied Digital Skills video tutorials (Create a Presentation "All About a Topic" in Google Slides) if they need help with the elements of creating a Google Slides presentation. This assignment is spelled out in detail on the Google Slides Rubric and Scoring Guidelines.
2. (3 days) Students will then work in the same groups to use all the information compiled so far to complete a Google Site containing 8 pages. Each student will complete 2 pages with their names on their pages. This project will count as 2 project grades for a total of 200 pts. Students needing assistance completing a Google Site may refer to the Applied Digital Skills video tutorials (Design a Website to Promote a Project). This project is spelled out in detail in the Google Sites Rubric and Scoring Guidelines.
3. (1 Day) Each group will share/present their website to the class via SMART board, Google Meet, or simply gathered around their computer.

Closing: Allow students to respond to each of the essential questions.

Lesson 3: "Let's Get Coding So We Can Start Flying!" (5 days, but will depend on the number of students and the number of drones available)

Objectives:

- Students will use Blockly (CoDrone Edu) or DroneBlocks (DJI Tello) to program drones to complete simple maneuvers (ie., take off, fly forward, land, yaw, pitch, roll, flip, etc.).
- Students will troubleshoot for obvious errors and debug their code before flying a drone.
- Students will use their program to fly a drone in the classroom.
- Students will be spotters for others who are flying the drone

Standards:

ISTE:

5D: Students understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions.
6A: Students choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication.

Materials Needed:

- CoDrone Edu or DJI Tello drones
- Chromebooks, smart phones, or tablets
- Safety Goggles
- Video Clip--Block Coding with Drone Blocks App and Tello Drone (8:51)

Activities:

NOTE: The implementation of Lesson 3 may vary depending upon each unique classroom situation (i.e. number of students versus number of drones). It may be necessary to overlap Lessons 2 and 3 to allow some groups to be doing research and working on their websites while other groups are programming and flying their drones in order to make sure that every student has an opportunity to program and fly the drones. Students will remain in their same groups of four for both lessons. If using the CoDrone EDU, there are very user-friendly tutorial lessons found at **Program Your CoDrone EDU (Tutorials)** This lesson will use DJI Tello drones. There are a plethora of YouTube videos that demonstrate how to program the Tello using the DroneBlocks app.

Before the lesson, please review drone safety for inside the classroom (i.e. designate a fly zone away the other students who are working, wear goggles when flying drones, tie hair back, don't fly near other students, make sure you have a "spotter" that is looking out for other students and giving guidelines to the flyer, etc.). Teacher will explain the roles of each person in the group, which will rotate.

1. Each group of four students will designate the following positions:
   a. Flyer—Student uses the Chromebook or tablet to run the code and fly the drone.
   b. Spotter—Makes sure that the drone does not fly too close to students or other objects.
   c. Coder/Programmer—Writes the code that will tell the drone what to do.
   d. Debugger—Checks the code to make sure there are not any obvious error in the code.

   Students will take turns performing each role. The Coder/Programmer can be creative with their coding, but the Spotter must make sure the code makes sense ("take off" block, but no "land" block, or "fly forward 10 inches" will fly drone into the window or wall).

2. Students can search for additional YouTube videos to help them program more complicated maneuvers for their drones to perform. Programmers and Debuggers should watch together.

Closing: Are you interested in learning more about drones? Are you interested in a career that uses drones? Are you interested in becoming a certified drone pilot when you turn 16?

Resources

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Annotated Bibliography

Drones, Drones, Everywhere! Paperback – March 16, 2023

by Ashlee Cooper (Author), Faye Paige Edwards (Author)

This book is to be used with the first lesson to introduce drones and drone safety. Although it is very kid-friendly, it can be used with any age.

Droneversity

This organization will help those who want to pass their FAA Part 107 Drone Pilot's test. It also shares about drone soccer and has other resources to encourage and support youth.

TRUST Exam

This is the test that needs to be completed by anyone who wants to fly drones recreationally.

YouTube Videos:

Role of Technology in the 21st Century Education (for educators)

This is a video for educators that stresses the need for educators to equip their students with the technological skills necessary to be successful.

Drone Safety (Canada) (For Students)

This is a student-friendly video about drone. Although it is for drone pilots in Canada, the rules are basically the same as for flying in the U.S.

What are the Rules to Fly Your Drone in 2023

These are the current FAA rules for flying a drone in 2023.

Drone Laws in the US

This video stresses the importance of acquiring a drone pilot license when not using your drone strictly for recreational purposes.

15 Beginner Drone Maneuvers

This is a video tutorial to practice flying a drone using a controller.

Block-Coding with Drone Blocks App and Tello Drone

This is a tutorial for using the DroneBlocks app with your Tello drone.

Drone Blocks Simulator for Tello Drone Coding

This video is important when not all students have access to a drone in the classroom, but they need to practice flying. However, teacher must have purchased the DroneBlocks curriculum to use it. ($500 for one year)

Ryze Tello Drone: How to Program your Drone with DroneBlocks App

This is another tutorial for programming your Tello drone.

Program Your CoDrone EDU (Tutorials)

These free tutorials will help you program your CoDrone EDU using BLOCKLY or Python.

Appendix

Standards

Common Core ELA Standards

WHST.6-8.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ETS1-2)
WHST.6-8.8	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.(MS-ETS1-1)

ISTE Standards

Standard 3 Knowledge Constructor: Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others.

<u>5D</u>: Students understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions.
<u>6A</u>: Students choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication.

Business, Computer and Information Technology Standards

15.4.8.G: Create an advanced digital project using appropriate software/application for an authentic task.

15.4.8.K. Create a multimedia project using student created digital media

15.6.8.L. Evaluate the accuracy and bias of online sources of information; appropriately cite online resources.

15.6.8.M. Explore and describe how emerging technologies are used across different career paths.

Other Resources

<u>Drones Worksheet</u>

For use in Lesson 1 to help students learn to identify different types of drones.

<u>Name These Types of Drones Quiz</u>

Quiz on types of drones.

<u>Drones Quiz Answer Key</u>

<u>Create a Presentation "All About a Topic" in Google Slides</u>

This is video-based instruction on how to complete a Google Slides presentation.

<u>Design a Website to Promote a Project</u>

This is video-based instruction on how to complete a Google Sites presentation.

<u>Drone Safety Handout</u>

<u>Drone Safety Quiz</u>

<u>Drone Safety Quiz Answer Key</u>

<u>Research Rubric</u>

Slides Presentation Rubric (Guidelines)

Google Site Rubric and Scoring Guidelines