The Sky's the Limit: Drone Technology, Place-based Learning, and the School Library

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During the pandemic, school librarian Dr. Kelly Passek of Blacksburg (VA) Middle School began using a drone to deliver library books to her students. After submitting their order using an online form, the librarian fulfills the requests and a Wing drone delivers their books and other media requests. The Wing drone carries up to three pounds of goods.

Drone technology applications are an effective way to engage youth in hands-on, place-based activities that connect with real-world global projects. Some schools are even offering high school courses in Aviation and Aerospace that feature drone technology.

INSERT FIGURE 1 HERE. School librarian packing books for delivery. Courtesy of Wing Aviation LLC.

INSERT FIGURE 2 HERE. Wing drone delivering in Virginia. Courtesy of Wing Aviation LLC.

Drone Technology and Licensing
Like 3D printers, drone technology once seemed "out of reach" for the school library. However the cost of Unmanned Aerial Vehicles (UAVs) has declined over the past several years. Professional-level Unmanned Aircraft Systems (UASs) that include a drone along with a ground-based controller and communication system can cost tens of thousands of dollars. On the other hand, inexpensive options are becoming more widely available for commercial, recreational, and educational use.

Quadcopters are particularly popular in schools because they're reliable, maneuverable, and hover easily. These UAVs contain four rotors and many models include a camera mount, global positioning system, and easy-to-use controllers.

Drones can be controlled remotely with a smartphone, tablet, laptop, or specialized controller. While some projects involve piloting the drone over an area for a birds-eye view, other projects require hours of programming to automate the flight path for specialized tasks such as automated payload delivery.

In the United States, the FAA has implemented licensing and safety requirements. Since the small drone registration rule went into effect in 2015, nearly two million drones have been registered. This rule applies to aircraft weighing more than 0.55 pounds and less than 55 pounds including items such as cameras and payloads. There are some exceptions for drones flown for recreational purposes. However the drone must still be registered. To learn more about registration requirements, go to **FAA: Register your Drone** <https://bit.ly/3j9uhtH> or the **FAADroneZone** <https://faadronezone.faa.gov/>.

In addition to federal regulations, many state and local authorities have established rules for drone operation. Explore restricted airspace in your state using the **Visualize It: FAA UAS Data Map** <https://bit.ly/3n78026> or the **B4UFLY Mobile App** <https://bit.ly/335jdIl>. For state legislation, go to **AUVSI Advocacy** <https://bit.ly/30dpe45>.

INSERT FIGURE 3 HERE. Visualize It: FAA UAS Data.

Involve students in examining airspace restrictions and comparing the regulations in different areas of the world. Use the Google Map project **Drone Laws for Every Country in the World (Recreational Use Only)** <https://bit.ly/3czG3uI> to get started.

The Federal Aviation Administration's **Drones/UAS YouTube Channel** <https://bit.ly/2G81HKK> provides short, useful videos on topics such as registration and safety.

INSERT FIGURE 4 HERE. FAA Drones/UAS YouTube Channel.

Place-based Education
Place-based education connects students with the local community by grounding learning in local phenomena and lived experiences. Rooted in Dewey's focus on authentic learning, place-based approaches include cultural and historical studies, nature exploration, STEAM applications, and real-world problem-solving.

Global Positioning Systems (GPS) are incorporated into most drones. Use the GPS capabilities in activities with fixed, stable locations such as USGS benchmarks, monuments or historical buildings. Also, use GPS to track changes in locations such as meandering creeks and coastal erosion.

From cemetery tours to wetland walks, students can use drones to participate in real-time adventures, create video tours, or conduct scientific experiments.

Real-World Applications
From archaeology and medicine to law enforcement, drones are used in a wide range of professions. Seek out local professionals who are willing to volunteer their equipment and skills with students.

For instance, the Delhi Unified School District in California is using drones as part of their safety operations. This technology is used to supervise students on-campus and enforce closed-campus policies. Connect with your local school district or law enforcement agency for drone demonstrations.

Check with local and state government offices for projects that involve drone technology for construction projects, archaeology investigations, or wildlife tracking. Seek out businesses that are investigating drones for cargo delivery. In rural areas, see if anyone is using a drone in agriculture.

Ask agency representatives if there are projects that could provide students with experiences using drones for authentic activities. For example, the Oregon Department of Transportation has involved students from the Salem-Keizer School District in conducting aerial mapping and surveying.

INSERT FIGURE 5 HERE. Student using a drone for aerial mapping. Photo Credit: Oregon Department of Transportation.

Explore the **USGS National Unmanned Aircraft Systems Project Office** <https://on.doi.gov/3kUT6db> page for lots of examples of drone use in a wide range of activities from tracing the lava flow at Kilauea Volcano to developing a flood management plan at Fort Laramie National Historic Site.

INSERT FIGURE 6 HERE. USGS National Unmanned Aircraft Systems Project Office.

For lots of examples of how drone technology is being used in a wide range of businesses and industries, explore the Small UAV Coalition's **Benefits** <https://smalluavcoalition.org/benefits/> page.

Curriculum Connections: STEAM
Many students will find the science of drone technology intriguing. While some youth will be interested in the attributes and properties of the materials used in drone construction, others may explore the physics (i.e., lift, drag, thrust) that make these drones fly. Angles, height, speed, and weight are just a few of the mathematics-connected considerations when planning drone projects. A Google search for drone STEM lessons returns dozens of classroom integration ideas.

Although drone technology is still expensive, seek out local hobbyists or government organizations that use the technology in their work. Involve teens in exploring ways that drone technology could be used in local projects such as agriculture or delivery services. For instance, drones are increasingly used in farming to apply pesticide, conduct research, and check the status of crops.

Dr. Larry Purcell from the University of Arkansas uses drone remote sensing in soybean research. He invites high school students to the Arkansas Agricultural Experiment Station to learn about the use of drones in research.

INSERT FIGURE 7 HERE. Drone remote sensing in agriculture research. Photo Credit: Fred Miller, University of Arkansas.

Drone technology is used in a wide range of environmental science activities such as monitoring wildlife activities and documenting natural disasters. Increasingly, drones are used as part of search and rescue operations and wildfire suppression activities.

Seek out opportunities to connect science with social studies topics. Whether delivering medicine in remote areas or detecting illegal drug operations, drones have become critical tools in many interdisciplinary fields.

Curriculum Connections: Social Studies and History
From law enforcement and military applications to humanitarian projects, explore issues of public policy and ethical use of this technology.

Privacy, automation domination, and workforce displacement are just a few of the many topics that could be used as a springboard for debate or speech assignments. Whether discussing the 4th Amendment Right to Privacy or investigating the best drone model for a particular task, encourage youth to dive into current events, new industries, and legislation.

Over the past decade, drones have become increasingly common in warfare and terrorism activities. Weaponized drones allow individuals and governments to reduce the risks of warfare. However, they also present moral issues associated with targeted killings.

In his article Drones, Balance of Power, and "Just War": Assassination and Warfare in a New Century, Mark Pearcy (2018, 58) suggests that educators need to help students grapple with the complex issues associated with this rapidly evolving technology. Pearcy notes that "whether or not drones are permissible under just war theory is an issue that students today need to evaluate." From executive orders to international laws and treaties, a wide range of primary source documents can be used to help youth understand the various perspectives and policies.

Drones are transforming archaeology research and our understanding of historical events. Projects at UNESCO World Heritage Sites such as the Petra Archaeological Park in Jordan are using drones to uncover previously unknown treasures. National Geographic videographers uses drones in many of their projects. For instance, watch **Amazing Drone Footage of Nubrian Pyramids** <https://bit.ly/3i966Kn>.

The Amache Internment Camp in Granada, Colorado housed over 10,000 Japanese American citizens and persons of Japanese ancestry in the 1940s. The **Mapping Amache Project** <http://mappingamache.com/> is using GIS and drone technology to create a 3D representation of the camp including roads, boundaries, housing, and other structures.

INSERT FIGURE 8 HERE. Mapping Amache Project.

Curriculum Connections: Art, Music, and Physical Education
Art, music, and physical education are all areas where drone use has become common.

Drones are used to produce spectacular paintings and other artwork. While some projects are pre-programmed using multiple drones, others use inexpensive devices and basic spray paint.

From the Olympics to the Super Bowl, Intel's Shooting Star drones have performed synchronized sky shows for a wide range of events. In some areas, synchronized drones are replacing fireworks.

Aerial photography is growing in popularity. Drones can provide images of rarely seen perspectives on the school grounds and neighborhood. Involve youth in guessing the locations where photos were taken. Encourage creativity by brainstorming locations for aerial photography such as cemeteries, forests, and fields.

From marching band formations to football plays, drones are effective in capturing the action. Use camera footage for debriefing activities. Or, involve youth in filmmaking ideas using drone photography.

Drone Ohio <https://www.youtube.com/c/DroneOhio/videos> YouTube Channel provides a wide range of examples including marching bands.

INSERT FIGURE 9 HERE. Hudson High School Swing Marching Band.

Drones in Makerspaces
Grants, corporate sponsors, and local organizations have all helped make makerspace areas in school libraries a reality.

Seek options for incorporating drone technology into your makerspace. Popular connections include agriculture, industrial technology, and computer science departments. For instance, many schools connect drone technology with Raspberry Pi coding projects.

DIY Drones at Instructables <https://www.instructables.com/id/DIY-Drones/> provides lots of examples of drone designs that could be incorporated into makerspace projects.

Both indoor and outdoor drones are available for K-12 activities. Many schools choose to purchase a package that includes the hardware, software, and matching curriculum materials rather than building lessons from scratch.

The DJI Tello, Parrot Mambo, Robolink CoDrone and FlyBrix are examples of indoor drones popular with educators. These smaller scale drones are inexpensive and a good place to start.

Outdoor options for educators include the RubiQ, STEM Ranger, MultiRotor, and DJI Phantom. The RubiQ along with the PCS Discover Drones is an example of a package that includes the hardware, software, and curriculum needed for success.

For dozens of activities and lesson ideas, go to **Academy of Model Aeronautics (AMA) Flight School** <http://amaflightschool.org/activities> or the **UCAR Center for Science Education** <https://bit.ly/2S6w06Z>.

If you already own a 3D printer as part of your makerspace, it's possible to print some of the parts needed to build your own drone. One of the advantages to this approach is that pieces can easily be reprinted if (or when) the drone crashes. Franklin Houser (2019) suggests that while you'll still need to purchase motors and sensors, it's possible to fabricate many of the drone components such as the frame, landing gear, and propellers.

Start your adventure by browsing websites that specialize in drones for beginners such as **BeginningFlyer** <http://beginnerflyer.com/> and **DIYDrones** <https://diydrones.com/>.

Technology Literacy

Drone technology provides a unique opportunity to collaborate with teachers across the curriculum. Connect the library's technology literacy curriculum with real-world projects. Involve youth in investigating how drone technology can be used to address local challenges or global issues. An inquiry into job creation and high-tech careers is another project that could be implemented across the curriculum.

Use the SOAR model as a way to think about integrating drone and robotic technology into the classroom (Carnahan, Zieger, Crowley, 2016).

- **Safety**: Ethics and legal issues
- **Operation**: Flight, maintenance, and troubleshooting
- **Active Learning**: Engagement in solving problems
- **Research**: Practical applications

Getting Started

Start your drone program by getting to know what's happening locally and nationally.

Step 1. Follow FAA's Drone Zone social media feeds including **Facebook** <https://www.facebook.com/FAADroneZone/> and **Twitter** <https://twitter.com/FAADroneZone> for up-to-date news and information. Share what you're learning with interested students and teachers.

INSERT FIGURE 10 HERE. FAA Drone Zone Twitter Account.

Step 2. Generate interest in drone technology by celebrating **The Drone Safety Awareness Week** <https://dronesafetyawarenessweek.com/> each November. The website includes ideas for learning and learning in addition to promotional activities.

INSERT FIGURE 11 HERE. National Drone Safety Awareness Week.

Step 3. Seek out volunteers to help with the program. Start with your local aviation group, interested parents, or community members who own drones.

The Federal Aviation Administration maintains a list of professionals and volunteers who can answer questions. Use their **FAASTeam Online Directory** <https://bit.ly/3mQnO98> to identify people in your area who might help get you started. These DronePro volunteers

have been trained by the FAA to promote safe drone use. They may also be able to talk with students or set up flight demonstrations. Search for DronePro in the online directory for a volunteer in your area.

INSERT FIGURE 12 HERE. Woods Hole Science Stroll. Photo Credit: Dann Blackwood, USGS.

Step 4. Form a student club or educator task force to gauge interest. Think about whether the program will be housed in the school library, a separate makerspace, or another school department.

Virtual Adventures
If purchasing a drone is beyond your means, you can still participate through virtual, drone adventures. For instance, the YouTube channel **Man and Drone** <https://www.youtube.com/c/ManAndDrone/videos> contains dozens of drone videos from around the world. Involve youth in learning more about the amazing places represented in these videos.

Drone Adventures <https://www.youtube.com/user/DroneAdventuresVideo> is a YouTube channel that provides examples of how drones can be used as a powerful, positive tool. They feature humanitarian projects and science investigations.

Drones can take students to places they wouldn't be able to visit in person. For instance, **Postcards from Pripyat, Chernobyl** <https://bit.ly/3i7YQOY> shares video footage from the Chernobyl Nuclear Disaster. Drone footage taken at the **Yasur Volcano** <https://bit.ly/36a2R3a> is an engaging way to demonstrate the power of nature.

Drone film festivals have emerged as a way for people to share their drone-based cinematography. Check out lots of examples at the **New York Drone Film Festival** <https://bit.ly/3j4mddA>.

Finally, **AirVuz** <https://www.airvuz.com/> is a video sharing platform for drone videos. They maintain list of "top videos" as well as "trending videos". For many other examples, do a Google search for YouTube drone adventures or best drone videos.

References
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