Work-based Learning Infrastructure for Using Drones in Real Estate

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Abstract
The recent appearances of moderately low-cost technologies have greatly expanded the possibilities for high school students to engage in high-tech work-based learning opportunities. The recent availability of moderately priced, high-quality, off-the-shelf drones presents itself as one such learning opportunity. Once only within reach of top-tier professional photographers with large equipment budgets, today's remotely controlled drone flight technology—with its high-quality cameras and powerful video editing software—is uniquely positioned to place professional grade equipment in the hands of students. The ability to match interested students with businesses that need high-quality videography—real estate sales companies specifically—presents a new opportunity to develop rich between schools and businesses that simultaneously provide an important learning environment for students and provide a valuable service to the community. Considerations for partnering with real estate companies include the need for students to: obtain FAA remote piloting licenses, develop precision flight skills, acquire and maintain drones adequate to the task, use digital video editing software, and implement entrepreneurial business skills.

Keywords: *work-based learning, business education, drone technology, aviation certification, real estate, digital video*

Introduction

In recent years, there has been a resurgence of career and technical education programs taking advantage of the expertise and learning opportunities available through local businesses. Known widely as *work-based learning*, these programs leverage partnerships between schools and local commercial businesses (Alfeld, Charner, Johnson, & Watts, 2013; Cahil, 2016). The essence of work-based learning programs is to connect classroom learning with the modern workplace (RTI International, N.D.). In doing so, students acquire first-hand, on-the-ground experience alongside professionals authentically working in a particular vocational domain. Although this can take a variety of forms, the most common described by Showalter and Spiker (216) can be summarized as: internships, apprenticeships, community service activities, and job shadowing. Perhaps most importantly, when done well, these programs have been long shown to enhance student knowledge, attitudes, and perseverance in completing high school graduation requirements (Wonacott, 2002). Given the need to do well, necessary infrastructure components have been identified for successfully using drones include: earning a FAA Remote Pilot Part 107 license; purchase and maintaining drone equipment; developing precision flight skills; acquiring photography and videography skills; learning digital video editing; and employing business acumen.

Literature Review

The importance for schools to provide work-based learning opportunities for students is being further buoyed up by federal legislation, sometimes providing tremendous financial support to participating schools. In particular, the use of work-based learning for teaching students has been emboldened and made actionable through federal legislation including: the *Strengthening Career and Technical Education for the 21st Century Act* (Perkins V, 2006); the *Every Student Succeeds Act of 2015* Sections 1112, 2103 and 4203 (ESSA, 2015); and the *Workforce Innovation and Opportunity Act of 2014* Sections 148, 159, 418 and 422 (WIOA, 2014). Each year, schools across the country work hand-in-hand with their state departments of education to widely distribute funds for career and technical education in programs that are targeted to work for local communities. Without such supporting federal funds, it seems unlikely that equipment-extensive career and technical education programs could flourish given the scarcity of public-school funding sources.

Work-based learning programs can and do appear across a vast range of business and entrepreneurial settings. As but one example, consider that residential and commercial real estate is a business that exists in nearly every community across the United States. Real estate businesses are often locally owned and operated, making them uniquely flexible for working with local schools. One reason is that the number of real estate businesses scale with the size of the community's population—more people in the community equates to more real estate businesses available for high school CTE programs to partner with. Another reason that real estate businesses make great partners is because their inventory is constantly changing, providing a wide diversity of marketing projects for students to engage with. Finally, real estate agents themselves are well acquainted with the educational process because they themselves are well aware of knowledge testing procedures, continuing education requirements, and licensure systems because they themselves must be periodically educated and licensed (McGrath, Wang, Jackson, Kämpf-Dern, Malone, Funk, & Geurts, 2020).

Real estate businesses can only be successful if they utilize contemporary business acumen. Such craft knowledge includes contemporary approaches to marketing, engaging in social media, conducting market analysis, working directly with customers, accounting and billing, and producing high quality products—in the present scenario, narrative, photographic, and cinematography-based marketing products. These are all things CTE students need to learn to successfully operate businesses.

Using remotely controlled drones to capture aerial photos and videos is a learned skill that applies in a number of different career fields. Drones are being successfully used by students to capture data in domains including agriculture (Saiful Iskandar, Noor Afiza, & Noor Atiqah, 2020), environmental sciences (Slater & Biggs, 2022; Smith & Mader, 2018), civic tourism (Slater, Biggs, & Sanchez, 2021), and digital arts journalism (Slater, 2020). Similarly, drones can be used by students to make photos and videos that highlight the characteristics of properties for sale from unique perspectives to support real estate marketing. In this way, the inclusion of drones is particularly ripe for students participating in career and technical education programs.

Necessary Components

Although modern drones are far easier to obtain and fly than off-the-shelf drones just a few years ago, preparing students to work alongside real estate agents requires more preparation than simply handing a student a drone. Figure 1 lists the required skills and certifications needed for students to fly drones in partnership with a real estate company. These components include at a minimum: earning a FAA *Remote Pilot Part 107* License; purchasing & maintaining drone equipment; developing precision flight skills; acquiring photography & videography capture skills; learning digital video editing; and, of course, learning to deftly employ business acumen in a collaborative environment. These are each described in more detail in the subsections that follow.

Figure 1. Drones in Real Estate Checklist.

- ☐ Earn FAA *Remote Pilot Part 107* License
- ☐ Purchase & Maintain Drone Equipment
- ☐ Develop Precision Flight Skills
- ☐ Acquire Photography & Videography Skills
- ☐ Learn Digital Video Editing
- ☐ Employ Business Acumen

While one might initially think that such a long list of diverse learning needs a drone-oriented work-based learning program in real estate might represent an unexpectedly large portfolio of skills to be learned, the portfolio of skills learned in such a program are likely readily transferrable by the student to a wide range of careers and entrepreneurial enterprises. Such a rich scenario represents a powerful work-based learning opportunity, especially if the student can work in an apprenticeship mode with a real estate company already deeply engaged in using drone technology.

1. Part 107 Licensure

Because drones are officially considered to be aircraft by the Federal Aviation Administration (FAA), all pilots working in a professional commercial capacity—those individuals that are earning money or participating in a venture that earns money—must have a FAA *Remote Pilot Part 107* license (Slater & Sanchez, 2021a). Students 16-years or older can make an appointment to take a 60-item multiple choice test over a 2-hour period at an official testing center, usually at a relatively large airport. The fee is approximately $175. The test itself queries specialized aviation knowledge that requires a considerable amount of preparation. Illustrative examples of what drone license seeking pilots must memorize are listed in Figure 2.

There are numerous sites on the Internet—far too many to list—that provide test preparation and practice test questions. The test itself covers the domains: loading and performance; controlled airspace; aviation charts; airport operations and procedures; weather; risk management; and federal regulations. A *Part 107* drone license is good for 24-months and can be renewed online by taking a relatively straightforward online test. For anyone involved in flying drones with commercial implications, this certification is not optional. For hobbyists who wish only to fly for personal entertainment or educators who are flying for purposes of teaching, earning an online FAA *T.R.U.S.T. Safety Certificate* is now required (Slater & Sanchez, 2021a).

2. Equipment Choices

The number of professional drones available for less than $2,000 (even less than $750) has skyrocketed in the past few years. At the time of this writing, the dominant brand name in the

Figure 2. Numbers Licensed Drone Pilots Know.

- ✓ 0.55 lbs to <55 lbs. The legally allowable range of drones that must be registered.
- ✓ 100 MPH (87 KT). Maximum drone speed legally allowed.
- ✓ 400 feet. The maximum height you can fly (or above a taller building within a 400-foot radius).
- ✓ 500 feet. Minimum number of feet below a cloud you must fly.
- ✓ 2,000 feet. Minimum number of feet horizontally from a cloud you must fly.
- ✓ 2,000 feet. The distance you should operate from a tower to avoid hitting tower securing guy wires.
- ✓ 3 miles. The minimum visibility to be flying.
- ✓ 3 miles. The distance your anti-collision lights must be visible from when flying during twilight.
- ✓ 30 minutes. The twilight zone before sunrise or after sunset when you can still fly WITH collision lights visible from 3 statute miles.
- ✓ 8 hours. The time that must pass since you have had alcohol and less than 0.04 blook alcohol level.
- ✓ 10 days. The maximum time you can take to file an FAA accident report.
- ✓ 30 days. The time you have to notify the FAA if you move.
- ✓ 90 days. The lead time required when requesting an FAA waiver.
- ✓ 1 year. Time that must pass after a final, felony narcotics conviction before you can fly again.

Adapted with permission from Slater & Sanchez, 2021a.

drone market is DJI and their Chinese-made products are far less expensive than most equivalent US-made drone products. Many schools have invested in the *DJI Mavic Mini 3* (<$1,000), shown in Figure 3, or ones of similar size and cost, including the increasingly popular *DJI Avanta* (<$1,600) with included VR Goggles.

Typical of many drones in this category, these drones weigh about 249 grams, have a battery life of about 25-minutes, have a high-quality 4K or better digital video camera, and have onboard flight computers that allow the drones to automatically

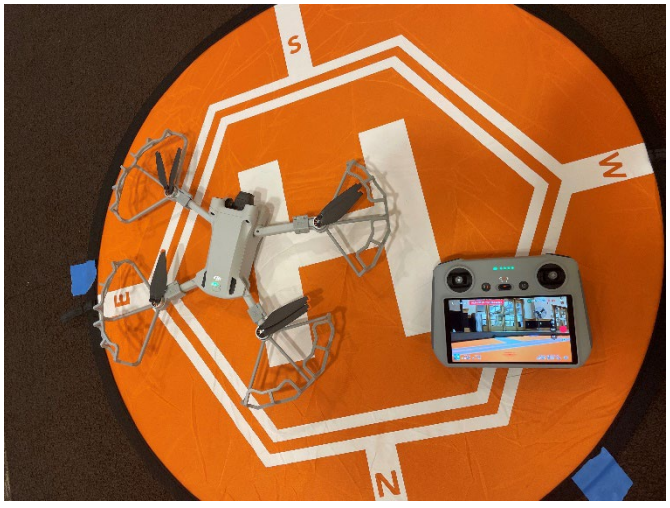

Figure 3. DJI Mavic Mini 3. *Photo Credit: Timothy F. Slater, Ph.D.*

hover in place during flight, even in winds up to about 20 mph. In addition to acquiring drones appropriate to the task at hand, a student pilot benefits from having extra batteries and extra replacement propellers immediately on hand.

For training purposes, some schools find other drones to be a better option. The most commonly used indoor drone for *SkillsUSA* UAV drone competitions seems to be the *Ryze Tello* quadcopter drone with a 13-minute battery life, a 100-foot range, and available for about $125. One advantage this lower cost drone has over others is that it is programable using standard block coding software programs, for those schools that emphasize computer science. Unfortunately, although excellent for indoor flight training and basic videography practice, the *Tello* itself doesn't work well for real estate applications that require outdoor flight in windy conditions.

Drones require maintenance, and students engaged in learning how to use drones professionally need to be able to keep a drone in working condition. The most common tasks are (1) keeping the drone and remote-control unit batteries charged appropriately; (2) conducting frequent software and firmware updates; and (3) perform calibrations of the compass and inertial measurement unit (IMU). The most common physical repairs drones need is the frequent and informed replacement of propellers. A drone's propeller blades are not identical or universal.

3. Precision Flight Skills

Concomitantly important to earning drone pilot certification and having a well-maintained drone is learning how to fly a drone precisely, safely, legally, and ethically. Although high school students who grew up playing modern video games seem to learn how to fly remotely controlled drones far faster than adults with less video game experience, students do need considerable practice to learn to fly with precision.

The experience of many teachers is that one of the best ways to encourage students to acquire considerable "stick-time"—time devoted to flying a drone—and systematically improve their flight skills is to devise flight mission challenges of increasing difficulty and complexity. Examples of precision flight mission challenges are listed in Figure 4. The possibilities for devising challenging flight missions are nearly limitless and experienced teachers often help students create precision flight mission challenges for one another.

Figure 4. Illustrative Precision Flight Mission Challenges.

- Knock down a pyramid of stacked plastic cups
- Land on an elevated, narrow shelf
- Fly by only using the drone's camera
- Land on an obscured target X
- Fly under a table, through its legs
- Minimize time to fly through an obstacle course
- Blow *Ping-Pong* balls along the ground to a target

Another promising instructional strategy for increasing students' precision flight skills is to provide opportunities for students to competitively improve their skills by using timed races around obstacle courses (*viz*., Slater & Sanchez, 2021b). Obstacles of varying sizes and heights can be quickly created using ½" PVC connectors and pipes cut to 30". Obstacles can

then be quickly arranged into an obstacle course gates to serve as a timed obstacle course, as illustrated in Figure 5. Experience suggests that the best courses often have two different sections: (i) one complicated section that reveals a pilot's precision flight skills and (ii) a second straightaway section that reveals a pilot's ability to fly controlled at high speeds.

Figure 5. Sample Racetracks & Obstacle Gates Created with ½" PVC.

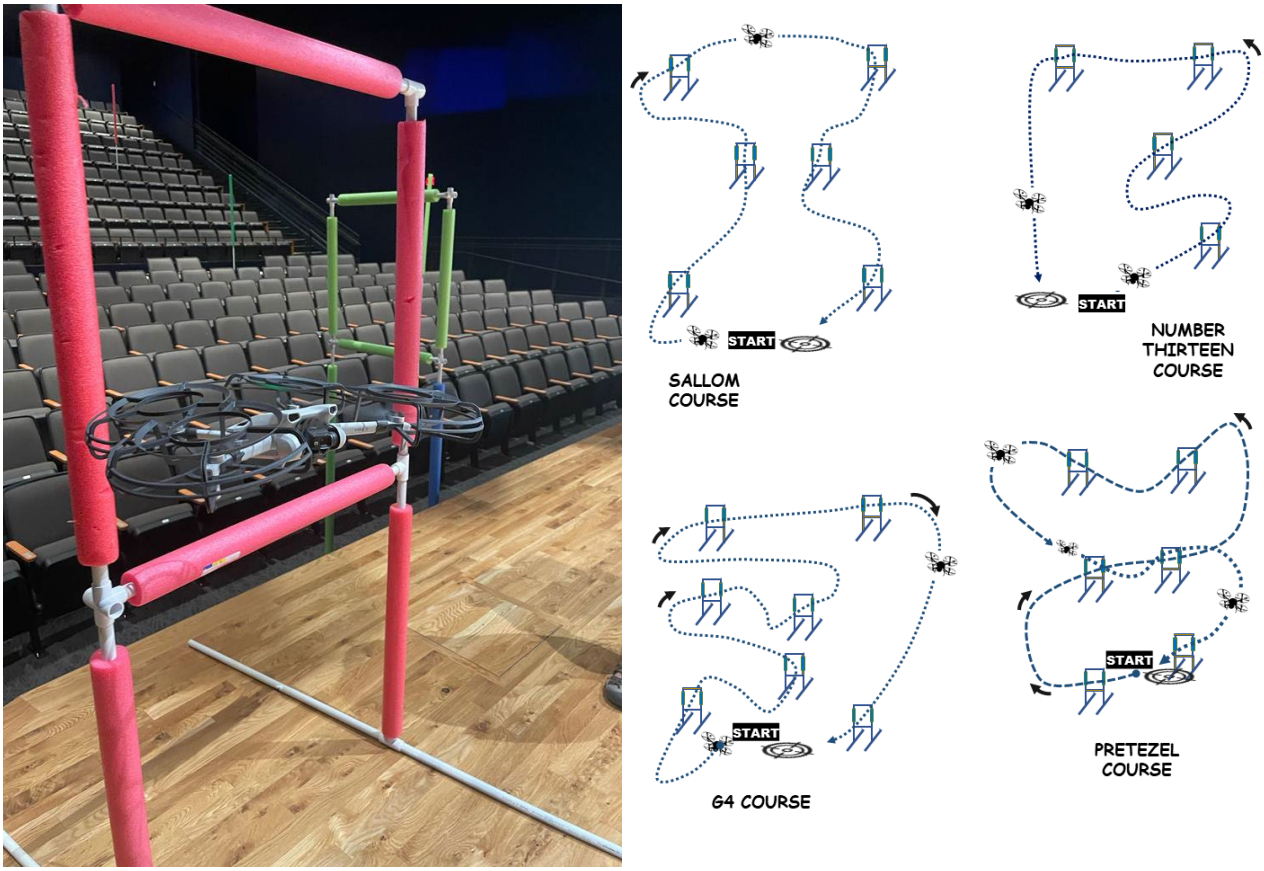

Photo & Illustration Credit: Timothy F. Slater, Ph.D.

Moreover, students can practice their flight skills without taking a drone outside using drone flight simulators. When using a drone simulator, students can practice flying through and around obstacles simply by using their haptic-enabled phone screens or by attaching a typical drone remote controller to a computer. The number of drone simulators available at present for smart phones, low processing power computers and tablets, and high-end, graphics capable gaming computers is far too extensive to list here. However, the most widely used drone flight simulator is *Velocidrone* (≅ $35). Many international, virtual drone races use the *Velocidrone* software as their platform, because of its low cost and great flexibility and customizability (Slater & Sanchez, 2021b). It is worth emphasizing that this software only works on computers and gaming laptops that have high-speed video cards, and it does not work well on low-end, cloud-based computers, such as the most typical Chromebooks found in U.S. schools.

4. Photography Composition & Cinematography Capture Skills

Composing well regarded photographs and creating captivating videos is a learned skill (Cheng, 2015). The components that make a drone image or drone-based video of interest require a combination and artful knowledge and combination of lines, shapes, texture, patterns, colors, lighting, and shadows. To be worth the cost and time required to use a drone to capture pictures and videos from unique perspectives and angles, students must allocate some learning time to developing knowledge of what constitutes "good" digital images—a learning domain typically far from the existing knowledge realm of most CTE teachers. Online courses and YouTube tutorials of varying quality are available for students to access across the Internet for low or no cost.

In the domain of creating unique photographs and videos that are of most of marketing use to partnering real estate companies, a shared understanding of what aspects of a property for sale are most important is ultimately important. In other words, the drone pilot creating useful digital resources requires information from the collaborating realtor about what needs to be highlighted, emphasized, and, naturally, deemphasized.

5. Digital Photo & Video Editing Skills

Acquiring high-quality, inflight drone video in accordance with safe, legal, and ethical constraints represents only ½ of the needed intellectual effort. These images and videos need to be "processed" to make them as attractive and useful as possible. Using software such as the industry-standard *Adobe Premier* package—or the no-cost but surprisingly similarly powerful Microsoft *ClickChamp* or IOS *iMovie*—to edit and enhance images or video already captured is known as "post-production" work. These largely intuitive programs are not difficult for students to learn and, like many technology packages, numerous online resources exist to teach students how to use them. It is in post-production where students stich together shorter video clips into a continuous presentation, change lighting and contrast using digital filters, add test and symbols such as arrows, and even royalty-free music when desired (*viz*., Slater, 2020). It is worth noting that a drone might capture a cumulative hour of video in order to create a compelling 60-90 second final product for a collaborating real estate partner.

6. Business Acumen, Marketing, Entrepreneurship, and Accounting Skills

Smith (2017) eloquently argues that the most successful high school CTE programs do more than teach vocational trade skills: He maintains that students benefit from learning business acumen and entrepreneurship skills so that students can eventually create their own businesses. This life-long learning view is consistent with the modern push for work-based learning programs where students and schools are emboldened to create revenue generating businesses that are needed by their communities (Cahil, 2016; Haviland & Robbins, 2021; Showalter & Spiker, 2016).

When it comes to providing business-to-business contracted photographic and video services to a community, the ever-lowering cost of drones is going to bring about more competition among potentially competing drone pilots. This means a successful drone piloting business working for real estate companies will be best served if they can develop their own marketing, hiring, outsources, and accounting skills innate to entrepreneurship. In the end, a complete work-based learning program will be best served if there is an intentional effort to teach students not just how to fly drones and make videos, but also to learn all aspects of running a successful business.

Coming full circle to what was described earlier as motivating this work, a meaningful partnership with a local real estate company will likely best be built around internship and apprenticeship models where students can learn all aspects of running a business.

Discussion & Conclusions

Few CTE high school teachers are well positioned to teach students all of the diverse skills needed for a successful work-based learning program that uses drones to partner with local real estate companies: earning federal licensure, knowledgeably purchasing appropriate drone equipment, acquiring precision flight skills with considerable practice time, learning digital video editing, and deploying the business acumen particular to real estate practices. This is where a solid partnership under a work-based learning model makes all of the difference. A solid real estate partner can carry much of the load of interning and apprenticing an interested student, relieving much of the burden on already very busy CTE teachers. Even though the list of required components seems long, it is well within the capabilities of interested student drone pilots if partnered with an engaged real estate professional. Moreover, implementing a drone-based real estate work-based learning program carries abundant gravitas for a school district and has real 'curb appeal' for recruiting future students into robust CTE programs.

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