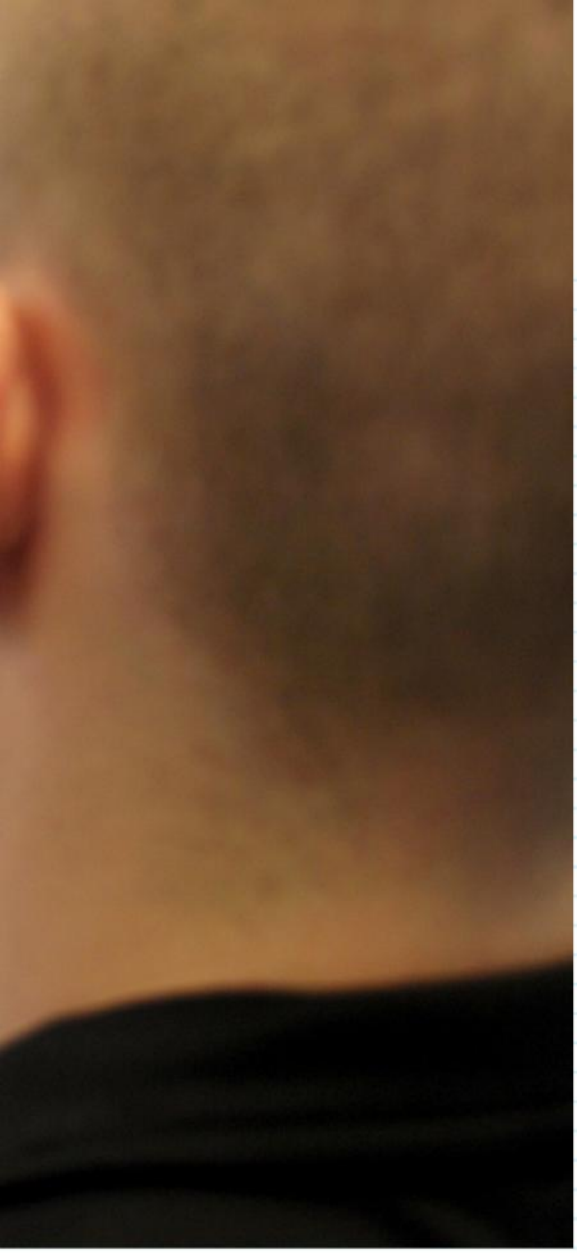
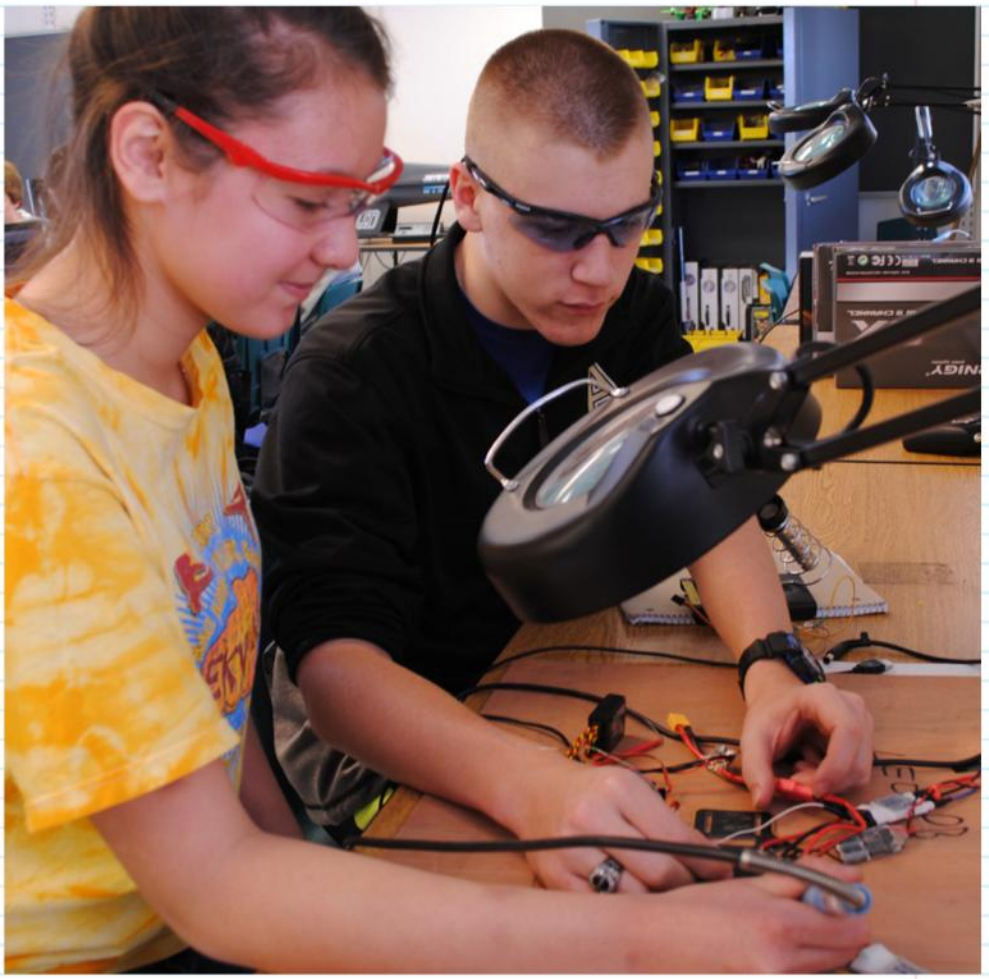
Students take Flight

Drones give kids new ways to explore science, technology, engineering, and math

By K.N. Smith





Drones are becoming more commonplace on university campuses around the U.S. But younger students are getting in on the action, too.

Middle- and high-school educators are discovering that drones offer an engaging way to teach science, technology, engineering, and math (STEM). And now, thanks to classes like Robert Tompkins' at South River High School in Edgewater, MD, kids interested in drones have somewhere to start.

Tompkins' classroom looks more like an engineering lab than a typical classroom. On any given day, students can be found using drone flight simulators, working on calculations, or 3D printing drone parts.

In 2013, with a grant from the avionics and information technology systems company Rockwell Collins, Tompkins started an unmanned aerial systems (UAS) class at South River for juniors and seniors.

The first year of the course, students learned the principles of flight, radio frequencies, and telemetry to build and program quadcopters. By its third year, the program expanded to two courses: an introductory class for juniors and an advanced capstone course for seniors.

Mr. Tompkins, Tech Ed.

One group of seniors built a lifeguard quad that tracks a target to drop a lifejacket to it. Another team designed a vertical takeoff and landing (VTOL) system that starts as a quad and converts to a fixed-wing aircraft in midair.

Tompkins says his class, now in its fourth year, is among the first of its kind,

Top left: Students often practice on drone flight simulators — where it's OK to crash and burn — in Robert Tompkins' class at South River High School.

Top right: Two South River High School students solder components together for a drone's prototype board.

ROBERT TOMPKINS (3), ILLUSTRATIONS/KELLIE JAEGER

Top: Students at Nikiski Middle/High School have to fly (it's a requirement!), so there are tons of awesome aerial shots of the school and its surrounding areas.

Right: Corey Upton (left), a University of Alaska Fairbanks graduate, helps students at Nikiski troubleshoot their custom hexacopter.

but drones are gradually becoming a more common sight in classrooms around the U.S. Courses that integrate drones into the curriculum provide an entry into STEM, inspiring students to pursue possible careers in aerospace, programming, engineering, and even drone law.

Higher education

One such program appeared in an unlikely place — Nikiski Middle/High School in Nikiski, AK, a community southwest of Anchorage with just over 4,000 people. Thanks to the combination of an Upward Bound grant and collaboration with the University of Alaska Fairbanks, the school created an after-school program to teach kids how to build, program, and fly small drones. The students even build their own airframes with K'NEX and then wire motors and flight controllers.

"If they got really good with [flying small drones], I would design obstacle courses in my classroom with hula hoops and things hanging from the ceiling," says Jacob Doth, middle school science teacher and coordinator for Nikiski's after-school drone program.

By the program's second year, students were flying automated missions with a hexacopter, piquing the interest of the rest of the student body.

"There was kind of a buzz in the hallway when my pilots would start their training session at the end of school," says Doth. "Next thing you know, you have a group of five or six folks standing around watching them fly, asking them questions about the drone."

Given the drones' ability to draw a crowd, he hopes to one day turn his after-school program into a year-long class.

But before takeoff, students learn flight safety and the ever-evolving laws and regulations for drone operations. Doth says that although the school board in Nikiski was "onboard from the beginning," the district contacted him early on to make sure that he was documenting safety protocols and had plans in place to follow applicable regulations. Tompkins' students call the local airports to confirm that they can operate in their airspace, and they've always received a go-ahead.

Understanding flight safety and regulations also helps students learn to handle stressful situations.

Take one of Doth's students for example: He was flying about 200 feet above the ground, but wanted to fly the drone higher, so he switched off the autopilot. Instead of gaining altitude, the drone immediately plummeted. Five feet before impact, the student realized he accidentally reversed the flight controls and managed to slow the drone down just enough to survive the landing.

"Everyone was cheering," says Doth. "He set the controller down, and he was wiping off his palms — he was sweating — and he kind of just looked at me and was like, 'That's the coolest thing I've ever done.' "

Passing the controls

Without similar programs, teachers have been developing curricula on the fly.

Both Doth and Tompkins' programs changed considerably over the first two years. The two educators worked tirelessly to find ways to not just teach how

JACOB DOTH (3), FAU UAV

FUNDING RESOURCES

Whether you're a teacher or a student, these websites can help get your drone program's propellers spinning.

YouCaring
This crowdfunding website's core focus is humanitarian causes, including schools and communities. Plus, it has zero fees!
youcaring.com

DonorsChoose
Teachers can create classroom project requests that the public chooses to back. Great for supplies!
donorschoose.org

Grants.gov
Search over 1,000 government grant programs and get information on how to apply for them.
grants.gov

After a practice run, students from a Florida high school make last minute adjustments to their drones' programming before competing at FAU UAV.

Mr. Doth, Science

to build a drone, but how to discover and innovate real-world applications for emerging UAS technology.

"The obvious STEM applications are never-ending, but what about the language arts, graphic arts, photography, and life skills?" Doth says. "I wanted the program to hit on as much as possible."

Since Doth and Tompkins didn't have exact courses to mimic, they turned to professors and researchers at universities for help — especially with the more advanced skills, like programming and circuitry, required to get drones in the air.

"I don't know everything, and I love telling the students that," says Tompkins, who uses those moments as a chance to encourage the students to research answers and contact professionals in the community for guidance. He says that help from industry professionals, including Rockwell Collins, is essential to his drone program's success.

At first, Doth regularly reached out to University of Alaska Fairbanks for similar help. "I was constantly calling Fairbanks and talking to their experts, going 'Hey, how do I do this?' and 'You know, I think my circuit board is fried, and I don't have a degree in circuitry,'" he says.

And sometimes the students take the lead — which is exactly what Doth and Tompkins want.

Last year, Doth and a group of students couldn't figure out a drone's wiring. He let them to work it out, and, not long after, they triumphantly flew the newly-wired drone into his office.

Vie while you fly

But for some, drones aren't a purely academic pursuit. High-school students, and even some middle schoolers, vie for trophies and bragging rights in drone competitions like the National Florida Atlantic University Unmanned Aerial Vehicle (FAU UAV) Championship.

In May 2017, the FAU UAV will hold its third annual competition for high

See how high schoolers in Nashville, TN, use drones to create artistic masterpieces Drone360mag.com

ICYMI!

Top: Teams conduct a faux search-and-rescue mission using drones, arguably the most exciting and difficult course at FAU UAV.

Above: Flying through rings might just seem like fun, but this five-ring obstacle course challenges students to create drones with a scripted flightpath program!

schoolers. Only two quadcopters, Parrot's Bebop and AR Drone 2.0, are allowed to compete. This ensures a level playing field and encourage teams to focus on coding. Competitions include an obstacle course, a time trial on a circuit course, and an extraction challenge that requires drones to retrieve and deposit a payload.

"In our first year, teams were challenged to deliver medicine bottles to 'villages' where the team knew the location of the villages and had to fly a recon mission to read QR codes to determine which medicine was to be delivered to each village," says Allan Phipps, FAU UAV advisor. "We saw a lot of creative 3D-printed parts for hanging the medicine bottles."

A similar competition for students is the Academy of Model Aeronautics-sponsored UAS4STEM, which held its first national competition in August 2016.

UAS4STEM teams face two challenges: First, students must program their drones for an automated flight to a series of waypoints. Second is a search-and-rescue scenario that requires teams to spot targets on the ground and mark them with GPS waypoints. But in order to participate in the UAS4STEM competition, teams must first complete an online ground school.

"The nice thing with the ground school is it's Part 107 compliant, so if the kids are old enough, they could conceivably have the information necessary to go out and get their commercial UAV license," says Archie Stafford, UAS4STEM director.

Once the educational component is complete, UAS4STEM ships each team a kit containing all the parts they need to build Quadzilla, a sturdy quadcopter custom-designed for the competition by Mid-Atlantic Multirotor.

These drone competitions spark friendly rivalries between schools, but Phipps hopes drone competitions will not only spark competitive spirit, but also an interest in STEM careers.

Beyond school

Both teachers and competition organizers want students to think about UAVs for more than just engineering and aerospace. They want students to know the drone industry includes programming, business, videography, law, and an evolving range of other potential careers. One of Doth's students has expressed interest in one day specializing in drone law.

Phipps also hopes participants leave the FAU UAV Championship with an interest in programming and knowledge that drones offer a chance for them to see their code literally take flight.

While coding is an important takeaway from competition, Doth also wants his students to get involved with scientific research. Just last year, they were lined up to help with research at the University of Alaska Fairbanks; however, due to equip-

ment damage, the project was put on hold. He hopes to resume in 2017.

Working with drones also helps teach students soft skills that are in high demand, such as problem-solving, teamwork, and communication.

Tompkins divides his classes into teams to collaborate on their capstone projects. In Doth's program, the students take on the roles of pilots, copilots, engineers, and photographers to simulate a working engineering firm.

The UAS4STEM judges even grade students on their interaction and problem-solving techniques, along with the accuracy of their waypoints.

"We're basically trying to get the kids ready for when real life comes and you have to work as a team and function as a team," says Stafford. "You're not going to have one person who's going to do everything. Everybody's kind of going to have their own little piece of the puzzle."

A drone in every classroom

Launching a comprehensive drone program for middle- and high-school students — and keeping it airborne — is an expensive endeavor.

Doth estimates an upfront cost of about $4,000 to start an after-school program similar to the one Upward Bound funded, and about $2,000 a year to keep it running. This is slightly more than the cost of starting a high-school robotics team for a competition similar to For Inspiration and Recognition of Science and Technology (FIRST) — the program estimates an initial cost of about $2,700.

A fully realized class will likely cost twice as much, which is highly inaccessible for most schools, especially without grants from outside sources. Doth's program, for instance, has no dedicated funding from the Nikiski school district and instead relies solely on grants.

"Without [Upward Bound], we never could have done it," Doth says. As of this writing, both he and Tompkins are waiting to hear about whether their program grants will be renewed for the 2016-2017 school year.

Despite the financial challenges, schools are constantly showing an interest in adding drones to their curricula. Tompkins says that he spends a lot of his free time fielding emails from teachers around the country, asking how they can do what South River has done.

"It all depends on what level of course you're trying to offer," he says. Even inexpensive toy quadcopters, which sell for about $50, are enough to help teach students about the physics of flight and basic engineering principles. And following the trajectory of computers, cellphones, and most other technology, even higher-quality drones are gradually becoming more affordable.

Tompkins hopes the growing popularity of drone programs will be the start of a trend toward hands-on, independent learning, based more on problem-solving than on lectures.

"These drones are the stepping stone to show that there's so much out there that these kids could be learning from," he says. "It doesn't have to be your typical educational setting. It doesn't have to be textbooks."

The traditional tools will likely still have their place in the classroom, but if interest in UAS for education continues to spread, drones could give STEM students a real lift. 360

All UAS4STEM competition teams receive a box that contains the components to make the Quadzilla, shown above.

"It doesn't have to be your typical educational setting. It doesn't have to be textbooks."

FAU UAV (2), UAS4STEM