Evaluating the “Drone the Unknown” 4-H Program Curriculum
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Abstract

Within the past ten years, there has been an increase in the demand for more STEM-based programs as is evident by the increase in STEM related careers and opportunities. In order to keep up with these career opportunities and continue to encourage youth to engage in developing technology, it is critical to expose them to programs highlighting STEM topics. Currently there is no official 4-H curriculum using drones as the main component for the instruction. This realization sparked the inspiration of a new program curriculum called “Drone the Unknown”. In this five-part curriculum, students are engaged with multiple STEM related SOL topics and 4-H life skills. This curriculum development and evaluation project serves to determine how effective this drone curriculum is in reinforcing these topics according to a review by 4-H professionals.
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Introduction

Background and Setting

In an ever-changing world, our youth in the United States of America are trailing behind other countries in Science, Technology, Engineering, and Math. American public schools use curriculum that revolves around standardized testing, but sticks to the mere basics in these subjects. Youth need the opportunity to have hands-on experiences in these topics to truly drive home the lessons as well as allow a more thorough understanding of concepts. As time goes on, more and more schools are cutting funding to these sorts of projects, and other agencies try to step in to fill this void. Youth also need the opportunity to experiment, practice critical thinking, and use creativity to solve the latest and greatest problems found in today’s society. The United States in the 21st century is experiencing a shortage of scientists, engineers, and other similar professions (Sallee & Peek, 2014). Sallee and Peek quote Donald T. Floyd, CEO and President of the National 4-H Council, "Our nation's young people are not acquiring the skills they need to excel in the fields of science, technology, engineering and math. That needs to change if we want to build a generation of workers who will make America a leader in innovation. Given the opportunity, today's youth can step up, become engaged, learn more, and become the inventors, rocket scientists and engineers of the future" (Sallee & Peek, 2014). There is an opportunity for 4-H as well as other outside programs to fill this void. Many agencies seem to have recognized this importance, and there has been an increase in the use of the acronym STEM.

By 2025, drones or UAS, Unmanned Aerial Systems, purchases are expected to increase by about 400% just in the agriculture industry (de Koff, 2017). Drones are used
in several other industries as well such as search and rescue, utilities, and the courier industry so that number is only expected to increase. With the expectation that drone sales will only continue to grow over the next ten years, it is almost guaranteed that the expectation that students are proficient in drone usage will also rise. Few research studies show the impact that drones can have on student learning, but several programs incorporate drones in STEM education according to de Koff. Jason de Koff refers to a study of drones that took place in 2007 which found that “the use of robotics was effective in teaching youth about STEM concepts such as computer programming, mathematics, and engineering” (de Koff, 2017). The use of robotics in this study can be equated with drones as they both involve the use of computer programming, mathematics, engineering, and more.

Over the past year, the “Drone the Unknown” curriculum (Appendix A) came to fruition after the discovery of a lack of curriculum for drone programs across the country. In 2016, the National 4-H Council chose a drone curriculum called “Drone Discovery” as the project for that year’s National Youth Science Day. Though a great introduction piece for drones, this program lacked a depth in programs to make it a full-fledged curriculum for 4-H. That short-term program sparked the inspiration to create the “Drone the Unknown” curriculum as a more permanent and long lasting resource. The curriculum itself contains five lessons geared towards ages 9 to 13 and has a focus on STEM education topics, drone usage, and many important life skills. Several Virginia Standards of Learning (SOLs) units are incorporated throughout the lessons to reinforce specific areas in mathematics, science, computer science, and computer technology.
Each lesson also incorporates a worksheet to help guide students through the lesson and brings the focus to SOL concepts.

The title of the curriculum evolved from the idea that drones are still a new piece of technology with many unknowns. The curriculum serves to explore these unknowns and make youth more confident and comfortable in handling drones. Youth also explore related careers to drones and the ways drones are used in the world today. Finally, youth are challenged to find new ways to use drones to benefit communities.

A large component of learning about drones starts with lessons on coding. Each lesson will require youth to successfully code to use the drone. The coding process from lesson to lesson remains the same, but the drone challenges in each lesson change. The youth will need to use critical thinking and problem-solving skills to work through various tasks. There are also design, planning, and engineering components in the lessons.

To make this program a versatile option for educators across the state, these lessons and worksheets were distributed to Virginia 4-H Extension Agents. Included with the curriculum was also an evaluation (Appendix B) of each lesson. The evaluation broke down the many SOL topics covered in each lesson and left open-ended questions as well. Life skills taken from the 4-H Life Skills Wheel (Appendix C) were also incorporated into the evaluation as overall effectiveness over the entire curriculum rather than by lesson. The final part of the evaluation allowed participants to leave any final improvements or comments for the curriculum.
Statement and Significance of the Problem

The Pew Research Center conducted a study with over 60 countries across the globe using tests in science, mathematics and reading with 15-year-old students. The cross-national test in this study is called the Programme for International Student Assessment which occurs every three years with the most recent occurring in 2015 (Desilver, 2017). In science, the United States ranked 24th, in mathematics, 39th, and 24th again in reading. The study showed that the United States fell slightly above average in science and reading, but fell below average in mathematics (Desilver, 2017). China was not included in this study but is known to have a strong education system as well.

Interestingly enough, the public perception of the education system in the United States similarly shows the lack of success in our students. In another study by the Pew Research Center based on the findings of an AAAS member survey, researchers compared the public view versus scientists’ view on science and society. In grades K-12, 29% of the public ranked U.S. STEM education as above average or the best in the world along with a mere 16% of AAAS scientists (Funk & Rainie, 2015). Furthermore, 46% of AAAS scientist ranked the K-12 STEM education as “below average.” To take it further, 75% of scientists agree that a major factor in the public's limited knowledge about science is because there is too little STEM education available for grades K-12 (Funk & Rainie, 2015).

These studies are important for educators on all levels and in all fields to realize. The education system is the basis for our society and represents the future of our country and the future of science. Exposing youth to better programs and increasing education standards can help improve our current system. Though these studies were
conducted with 15 year-old students, one can assume that by exposing these youth to science curriculum early and often, the students would be better prepared for future science topics.

As discussed previously, the National Youth Science Day in 2016 included a short term program on drones. This choice in topics shows the significance and interest that has grown around drones of the past few years. In addition to that 2016 NYSD, the 2018 day was centered on coding (4-H National Youth Science Day, 2018). These two topics go hand-in-hand, and their choice as the main subject for a national project signifies the magnitude of their potential for youth. Both of these programs touch on related industries and pathways in those fields.

Purpose of the Project

This project serves to investigate if a newly created drone curriculum can help public-school students improve STEM learning outcomes as well as garner interest in the various industries currently using drone technologies and coding. Students will have the opportunity to fly drones and practice coding to complete tasks that range from simple to complex. The curriculum is designed for fourth through sixth grades and will require teamwork and communication skills, which remain an important part of the challenges. Life skill development will also be rated as it is a large component of the 4-H Learning Model. Completion of the project by the evaluation respondents should bring light to the importance of incorporating new curriculum into an ever-changing world to help prepare our youth for the future.

It is the hope that this project will signify the potential usage of this curriculum in educational settings. For this to happen, evaluators need to see the value the
curriculum has in teaching SOL units and life skills. Ideally, evaluators will choose most responses to the SOL units and life skills as “very effective” to “extremely effective”. Should any response receive the “not effective at all” selection, that particular SOL or life skill needs to be reexamined and modified to reflect a more appropriate level of effectiveness.

Central Question:
How does the “Drone the Unknown” curriculum reinforce fourth grade Virginia STEM Standards of Learning and targeted 4-H Life Skills?

According to the current Virginia 4-H educators, the following were rated based on the curriculum as written:

a. How effective is the drone curriculum in aligning with the fourth grade Virginia Standards of Learning specifically regarding the scientific method/experimenting, explaining why things happen in an experiment, gathering data, building things to solve a problem, working towards success as a team?

b. How effective is the drone curriculum in enforcing the development of targeted life skills based on the model created by Iowa State University such as communication, cooperation, goal setting, problem-solving, personal safety, etc.?

c. How does the drone curriculum influence student interest in learning more about STEM and thinking about pursuing a career in STEM?

Definition of Keywords/Terms

Drones (UAS): “An unmanned aircraft system (UAS), sometimes called a drone, is an aircraft without a human pilot onboard – instead, the UAS is controlled from an operator on the ground” (Unmanned Aircraft Systems).
Coding: “The primary method for allowing intercommunication between humans and machines” (Coding). The process of which will be used for youth participants to write the script of the tasks they want the drone to perform.

STEM: Refers to Science, Technology, Engineering, and Mathematics

4-H: “4-H is delivered by Cooperative Extension—a community of more than 100 public universities across the nation that provides experiences where young people learn by doing. Kids complete hands-on projects in areas like health, science, agriculture and citizenship, in a positive environment where they receive guidance from adult mentors and are encouraged to take on proactive leadership roles. Kids experience 4-H in every county and parish in the country—through in-school and after-school programs, school and community clubs and 4-H camps” (What is 4-H?).

**Review of Literature**

Technology increasingly becomes an important aspect of everyday life. It is created and changed daily. As our youth grow older, they will be expected to find new and innovative solutions to our ever-changing problems (Virginia Department of Education, 2008). Researchers often look to technology to solve these problems and to find an alternative solution. Science, Technology, Engineering, and Math (STEM) disciplines continue to lack in opportunities in comparison to countries across the globe, which only hurts future opportunities for students. Statistics gathered from the National Center for Education Statistics in 2015 shows a drop in achievement in math proficiency from 2013 to 2015 in both fourth and eighth graders. The statistics also show a score comparison of the
average scores of 15-year olds from the Program for International Student Assessment. These scores show the United States trailing behind in Science, Mathematics, and Reading with 23 countries scoring higher in science and reading and 38 countries scoring higher in mathematics (Stephens, Warren, Harner, & Owen, 2015). It is important that our students are achieving at the same levels if not higher than other students around the globe. With more and more careers becoming globalized, American students will be competing with students in these higher-achieving countries and expected to reach the same achievements within the same period.

According to Roger W. Bybbee, STEM literacy refers to an individual’s “understanding in STEM disciplines, knowledge and skill to identify real-life issues and questions in STEM-related issues, engagement in STEM-related issues as a duty of a citizen, and awareness of how STEM disciplines shape the world we know today” (Bybee, 2013, p. 5). Helping students reach a high level of STEM literacy across the nation is one of the many goals of STEM education programs. One of those programs helping kids reach a higher level of STEM literacy is the 4-H Robotics and GPS/GIS Programs. A study conducted in Nebraska examines the power of “digital manipulatives” in 2008. According to this group, digital manipulatives include “technology like robotics and GPS devices that allow youth to build and experiment with physical objects” (Barker, Grandgenett, Nugent, & Adamchuk, 2010). These tools also include things like graphing calculators and computer based laboratory devices and are put in place to make the instruction of science, technology, and engineering more “relevant, interesting, and effective” (Barker, Grandgenett, Nugent, & Adamchuk, 2010). In Nebraska, this same group of researchers sought to determine if their particular
programs of robotics and GPS/GIS would better prepare the youth participants for the workplace. The programs provide the opportunity to learn science, technology, and engineering concepts, to learn about careers related in these fields, and to develop a positive attitude about the concepts as well as the opportunities (Barker, Grandgenett, Nugent, & Adamchuk, 2010).

The results of this study on the digital manipulatives used by the Cooperative Extension in Nebraska showed a definite correlation between the use of technology and an increase in STEM content knowledge. These results were determined by pre- and post-test scores amongst six different groups who participated in the programs. The researchers felt the results were overall positive, but recognized that more research is needed (Barker, Grandgenett, Nugent, & Adamchuk, 2010).

Over the years, 4-H programs have proven to provide high-quality STEM programs to youth around the country through various avenues of the curriculum. The National 4-H Council partnered with Tufts University to conduct a study on the effectiveness of 4-H youth development programs throughout more than ten years. The findings of this study were very positive regarding how effective 4-H programs have been on participating youth. For this project, one of the most meaningful statistics drawn from the study is the confirmation that 4-H youth are nearly two times more likely to participate in STEM programs out-of-school time (Lerner & Lerner, 2010). While this is a favorable statistic of the programs provided through 4-H, technology continues to improve and grow, and therefore, 4-H programs should as well.

Utilizing the 4-H Essential Elements, which include positive relationships with caring adults, safe environment, inclusive environment, engagement in learning,
opportunity for mastery, opportunity to see oneself as an active participant in the future, opportunity for self-determination, and opportunity to value and practice service for others, 4-H programs can go beyond in school curriculum (Sallee & Peek, 2014). By allowing an opportunity for mastery, youth can take the basic information learned in school and take it to the next level with 4-H. There is no current 4-H curriculum implementing the use of drones into STEM subjects that could help with this theory.

Jason de Koff expresses a need for Extension to develop educational programs for Unmanned Aircraft Systems or UAS due to the growth in sales over the past several years for both youth and adult participants. In his article, de Koff correlates the increase in sales to a need for an increase in educational UAS programs (de Koff, 2017). This new and upcoming technology is causing continued changes in regulations as the FAA tries to keep up with the latest designs. Regulations on certain types of UAS or drones have loosened which allows for wider use of the technology (de Koff, 2017). Prices have decreased, and drones can be found in various shapes, sizes, and functionality allowing for easier access and more purpose to drones. However, due to the lack of educational programs available, Extension is in a great position “to develop and implement curricula to meet UAS-related educational needs” (de Koff, 2017).

Other studies have shown how coding also plays a role in the development and understand of engineering in youth. In 2015, a study was done in Hong Kong called “School Perceptions of Coding Education in K-12: A Large Scale Quantitative Study to Inform Innovative Practices”. The authors recognize that “teaching students how to code in K-12 classrooms is considered one of the major keys to promoting engineering education” (Wong, Cheung, Ching, & Huen, 2015). Not only does teaching this
component to promote furthering engineering education, but it also “can potentially enhance the competency and computational skills of students to adhere better learning outcomes in higher education” (Wong, Cheung, Ching, & Huen, 2015). The authors concluded from their study that there are definite obstacles facing certain schools that limit education in coding; however, some schools have voluntarily implemented coding lessons on an individual teacher basis. The study concluded that it the real problem is “the absence in [a] coding curriculum” (Wong, Cheung, Ching, & Huen, 2015).

Drones have quickly become a forefront of the new opportunities technology can provide us with companies like Amazon changing the online shopping and delivery industry by use of drones with its growing business. According to Forbes, Amazon reported a 30% increase in net revenue in its fourth quarter (Team, 2018). As the new technology has continued its importance, technology and vast development has also allowed the market to offer drones at a more affordable value. With these numbers, there is a huge potential for drones in industries similar to these such as FedEx, United Parcel Service (UPS), and even the United States Postal Service.

The agricultural industry has also experienced many positive outcomes from the use of drones. As the world population continues to grow and thus the need for food, the agricultural industry has turned towards new technologies to become more efficient. Previously, farmers relied on satellite technology for large scale farms to examine fields and terrain. With drones or UAS’s, farmers can quickly obtain a bird’s eye view to detect problems with more precise data and details than the images the satellite can provide (Tripicchio, Satler, Dabisias, Ruffaldi, & Avizzano, 2015). There is potential for growth in addition to quicker imaging in the agriculture industry. In the future, these drones could
be used to find and track livestock, spread chemical safely and efficiently, and check areas harsh terrain faster than other technology.

This technology can provide more efficiency to the industry at a more affordable price. There is an opportunity for 4-H programs to engage youth in a technology that has many opportunities to change our world. With the flexibility to be used in and out of the classroom, a drone curriculum is needed to help build STEM literacy and make United States youth more competitive in the workforce. The “Drone the Unknown” curriculum overview in Appendix A provides youth the opportunity to learn drone coding, explore new technology, and compete in fun and engaging challenges.

**Project Design and Methodology**

*Design*

The evaluation project was designed by taking the SOL objectives from each lesson and inputting them into an evaluation in addition to a section on life skills and real-world connections. Each set of SOL objectives were separated within the lesson. Lessons ranged in SOL concepts from five to seventeen. Some SOL concepts were repeated in multiple lessons, and this was to specifically determine how each lesson effectively reinforced the SOL concepts. The SOL concepts were taken from the Virginia SOL webpage and written out fully within the evaluation in a matrix. The upper part of the matrix listed five options: Extremely Effective, Very Effective, Moderately Effective, Slightly Effective, and Not Effective at All. In addition to the SOL concept matrix, each page contained open ended questions where respondents can comment on the parts of
the curriculum that need improvement and the parts that were well done. This allow respondents to leave specific critiques within each lesson.

The evaluation design was divided in this manner to help break up a long survey and also to follow along with the curriculum design. Respondents could easily focus on one lesson at a time when review the SOLs without flipping back and forth between lessons. While this made the overall evaluation longer than recommended, the researcher felt the design was easier to follow in this way.

The last portion of the survey was designed to allow respondents a chance to rate the curriculums overall effectiveness to reinforcing life skills. The life skills ranking was not completed individually by lesson due to the build in skill development as the lessons are completed. All 17 life skills were listed on this last page. In addition, two more open-ended questions were created for respondents to make positive and negative remarks on the curriculum as a whole. All the open-ended were left as optional for the respondents to complete.

Methodology

The “Drone the Unknown” curriculum is designed for ages nine through thirteen but can be adapted for other age groups. This project focuses on the evaluation of the curriculum solely from the standpoint of educators. The curriculum was shared with 4-H specialists, other 4-H Extension Agents, and other representatives receiving information through the statewide 4-H listserv. These participants reviewed the curriculum materials lesson by lesson and assess the potential for the curriculum to support STEM instruction in a classroom and help teachers reinforce specific standards of learning and life skills through an engaging, hands-on program.
This project uses both Quantitative and Qualitative methods to collect data. The evaluation is designed in a way that respondents can give their opinion on the effectiveness of the curriculum to certain concepts, but there are also open-ended questions that allow for broader statements and opinions to be made. Each SOL concept and life skill is ranked based on the respondents’ knowledge to be extremely effective or not effective at all.

The basis of the curriculum is based on the Situated Learning Theory originally developed by Jean Lave (Lave, 2017). Because of the nature of this program, the Situated Learning Theory perfectly describes how participation in the drone activities in the curriculum can inadvertently influence youth in their skills and knowledge. The theory states that “[k]nowledge needs to be presented in authentic contexts”, and the “Drone the Unknown” curricula has lessons designed around this theory. The lessons engage the learner in a setting that require certain knowledge to be used. In the curriculum, the participants are tasked to design, build, and implement a variety of projects. It is in the engagement of these activities that situated learning occurs. It is also imperative in this theory that learners are collaborating and socially interacting (Lave, 2017). The curriculum places participants in teams in four of the five lessons to work together in an engaging activity. All of these components come together in order for situated learning to occur.

Though 4-H is not directly mentioned in the theory concepts, the principals support the 4-H Programming Model due to the connection with experiential learning and hands-on program development (Norman & Jordan). David Kolb discusses the experiential learning theory in his book, Experiential Learning: Experience as the
Source of Learning and Development, and there are clear similarities in experiential learning and the Situated Learning Theory. Kolb describes experiential learning “as a particular form of learning from life experience” (Kolb, 2015). Both the experiential learning theory and the situated learning theory support the idea that the “Drone the Unknown” curricula can reinforce SOL concepts through the hands-on activities through the program.

Additionally, several studies were conducted since the idea of the experiential learning theory began. Through the findings of these in psychology, medicine, accounting, and law, the experiential learning theory has been “widely accepted as a useful framework for learning-centered education innovation, including instructional design, curriculum development, and life-long learning” (Kolb, 2015). This idea supports the efforts to reinforce SOL concepts and life skills in the “Drone the Unknown” curricula.

These theories are important to emphasis so others can understand how the curriculum is able to reinforce the learning concepts. Understanding that these educational theories can positively affect youth in learning concepts, supports the idea that the “Drone the Unknown” curricula is capable of the same. The lessons in the curriculum use these theories in effort to strengthen the understanding of SOL concepts and life skills in the youth participants.

These theories come together in the principals that make 4-H programs successful. Nationwide, 4-H educators design and implement programs using the Experiential Learning Model. The Experiential Learning Model adapted by Pfeiffer and Jones has five specific steps involved in the process (Janning, Scholtz, & Krehbiel,
The first being the participant experiencing the activity. The next steps are
sharing and processing those experiences, and then finally generalizing and applying
the results, reactions, or observations. These can be categorized into three actions
rather than the five steps. Those would be as follows: do, reflect, and apply (Norman &
Jordan). These steps show direct correlation between the Experiential Learning Model
and Kolb’s Experiential Learning Theory. Both revolve around hands-on, activity-based
programming to support learning. Nearly every national 4-H curriculum implements
these steps. The steps are supported by both the Experiential Learning Theory as well
as the Situated Learning Theory.

The curriculum itself identifies key life skills as well as corresponding SOL topics
that are taught through participation in the activity. These lessons may be intentional,
but the participants are unaware of the educational benefit that occurs with their
participation. The lessons and activities are designed to be fun, hands-on, and
educational.

Data Collection

The evaluation was created using the Qualtrics survey and evaluation system and
distributed over the statewide 4-H email list following an ignite presentation at the
Virginia 4-H Symposium at the Natural Bridge Hotel. Scales ranking the effectiveness of
each lesson to reinforce SOL units were used to determine how successful the
curriculum is to meet those standards. The scale started at “Extremely Effective” to “Not
Effective At All.” In addition to ranking the SOL units, participants were also asked to
rate the effectiveness of the curriculum to teach specific life skills using the same scale
of “Extremely Effective” to “Not Effective At All.” Each lesson was organized as separate
blocks as to not overwhelm the participant and to help arrange the layout of the survey in a way that makes sense. The survey concludes with open ended questions for respondents to leave final remarks and suggestions.

The purpose of the survey was to ask questions in a manner that determines the quality of the curriculum as presented. It was a cross-sectional survey conducted at the conclusion of the review of the new curriculum (Creswell, 2014). Quality was determined by the ability of the lessons in the curriculum to meet certain standards and engage learners in specific tasks. These include the ability to teach critical thinking skills, the ability for students to work together as a team to perform a certain task, the ability to teach coding, and the ability for students to make a real-world connection, to name a few.

This survey method is preferred for various reasons. Electronic surveys are fast and easy to create and are also the most convenient for the target audience being that those target in Extension is located across the state. The Qualtrics system in itself has many features that can be beneficial to the study as well. It works well on phones, tablets, and computers for the most effective distribution. Don Dillman states that “the percentage who are responding to online surveys on mobile devices is growing,” and Qualtrics shows a preview of the survey view from a mobile device (Fielding, Lee, & Blank, 2018). Research has also shown the importance of a visually appealing survey to increase survey responses. Important survey design includes font choice, spacing, font size, spacing, and symbols that are chosen in the survey (Stern, Bilgen, & Dillman, 2014). The “Drone the Unknown” survey will have basic font styles in the standard font size. No symbols will be utilized, and Qualtrics spaces questions out independently to
allow for concise reading and flow. Stern, Bilgen, and Dillman delve into how the survey development varies from population to population.

While one method may be appropriate for a particular group, it may not work well with another. The biggest issue with web-based surveys recognized by Stern, Bilgen, and Dillman is the possible lack of access and the “swipe-happy” world. Due to the “Drone the Unknown” survey being distributed to extension professionals, access is not an area of concern. Reviewing the results in the Qualtrics system also proves to be an effective method as the results can be converted in an excel spreadsheet and are password protected. Qualtrics can also send reminders to the participants who have not completed the survey by a certain point in time while keeping the responses anonymous through a personalized link for each participant. It is a cost-free method that is the most efficient in its features. The program is cost-free only because of the researcher’s institution buying into the program.

Summary of Outcomes, Discussions, and Recommendations

Project Outcomes and Results

To numerically represent the data, each effectiveness level will receive a numerical value from 4 to 0. Four represents the most effective value and the option of “extremely effective” while zero represents the least effective and the selection of “not at all effective.” Because there were nine responses, an average of each concept can be taken when all numbers are added and divided by nine. With these numerical values, the score of a two would represent an average score.
In Lesson One of the “Drone the Unknown” curricula, results varied widely on the effectiveness of the curriculum over the ten SOL topics covered. This lesson focuses primarily on the basics of coding before bringing in drones for implementation of the concept. There were three SOL concepts that scored below three at 2.5, 2.5, and 2.6. These concepts shown in Appendix D include a two math SOLs and a computer science SOL. On the other hand, the other ten SOL topics scored above a three which corresponds to “very effective” to “extremely effective.”

Comments from this lesson indicated a need for a better explanation of real-world applications of coding to participants. Also, the lesson should introduce potential job opportunities through coding. Respondents felt that the instructions were very user-friendly and clear. One noted how the lesson worked well for both visual and kinesthetic learners.

Lesson Two overall had very positive results over the 17 different SOL concepts reinforced within the lesson. All SOL concepts in this lesson were rated on average above a three which falls between “very effective” to “extremely effective.” None of the respondents selected “slightly effective” for any of the 17 different SOL topics.

The comments in lesson two were short and in some ways contradictory to one another. For example, there were responses from some evaluators indicating that the directions on the student worksheet “could be more clear” whereas two other responses noted how well the worksheet was done and how it “listed out exactly what the students needed to complete [it]”. These discrepancies could be due to the differences in evaluators’ understanding of STEM concepts or due to the evaluators’ differences in learning styles. Respondents commended on the thoroughness and easy to use
worksheet that went with the lesson. There were a few minor changes that were suggested to make the instructions clearer for certain users.

Just as in Lesson Two, Lesson Three also saw an average on all SOL concepts of three or more indicating that each SOL concept fell on average between “very effective” and “extremely effective.” Also, this lesson also contained 17 SOL topics and received zero “slightly effective” responses. Respondents commended the engineering aspect in this lesson and had very little suggestions for improvement other than more paper space for the design process on the student worksheet.

In the fourth lesson, 16 SOL concepts were covered, and four of those concepts were selected by all nine respondents as “extremely effective.” One SOL in this lesson fell to a score of 2.7 which still falls between “moderately effective” to “very effective” but is the only SOL in this lesson to fall below three. This SOL concept is a math SOL just as occurred in the first lesson. Comments from this lesson noted the practicality of the lesson to real-world applications as well as the clear flow of instructions and concepts.

The fifth and final lesson changes gears and includes five SOL concepts. All five SOL concepts were rated on average between “very effective” to “extremely effective.” In addition to the included SOLs, one respondent suggested looking into adding English SOLs for this particular lesson because it incorporates public speaking. Participants commented on how this lesson ties it all together and brings in an important life skill for students to practice.

Another part of the evaluation included ranking the effectiveness of life skills. Throughout creating the curriculum, seventeen life skills were selected as evident. Through the evaluation, participants agreed that most of these life skills were effectively
met. Three life skills scored the lowest: self-esteem, personal safety, and service learning. One life skill received “extremely effective” from all nine respondents, and that was problem-solving.

In the final piece to the evaluation, participants were asked what improvements were needed and what things they liked about the curriculum. They could also select how they felt the curriculum related to real world concepts. The most common suggestion included adding more lessons either for coding or to make it a six-lesson curriculum. The researcher believes the six-lesson curriculum idea is taken from the national standard that signifies a minimum requirement of six hours of programming in order for youth to be considered a 4-H member. This standard has led to many curricula being created with six, separate one-hour lessons. In the design of this curriculum, it was decided to only have five, strong lesson plans partly due to the fact that many of the lessons will exceed one-hour, and thus youth participants will still receive the six hours needed to be considered a 4-H member. The developer of the curriculum felt that the five lessons were strong and forcing a sixth lesson could hurt the overall product. Making the curriculum too long could also result in a decrease in participation due to the time requirement.

The researcher understands where adding more lessons on coding could be beneficial especially to those with minimal experience on the topic. This is also evident by the most recent National Youth Science Day topic: coding. Similarly to the request of more coding lessons, one respondent suggested making cheat sheets for instructors who may have a harder time grasping certain concepts.
On the positive end of things, participants felt the curriculum was very timely and appropriate. Almost all commended the great level of hands-on activities. A note on the worksheets was also made that they were helpful and organized. Overall, participants were supportive of the curriculum.

Project Outcomes and Results Analysis

The results of this evaluation directly reflect the theoretical concepts described in the methods section. The theory of the Situated Learning Theory created by Jean Lave suggests that participation in an activity or a program such as the “Drone the Unknown” Curriculum leads to new knowledge through experience (Lave, 2017). Lessons developed in the curriculum are designed to be engaging and hands-on and may not specifically define SOL concepts or life skills, but through active participation and according to the respondents to the evaluation, it can be said that the curriculum will be effective in reinforcing those concepts and life skills. Respondents also recognized the successful teamwork skills being developed through the program. The idea that social interaction plays a role in learning also supports the Situated Learning Theory. Another piece in that theory that respondents commended is the practicality of the activities being performed and that students. By working through these real and applicable problems, students are learning to solve problems in an authentic environment.

Several evaluation respondents noted the clear dynamic of the program as hands-on and engaging to participants. These indicators are important in following the 4-H Programming Model as well as the Experiential Learning Model adapted by Pfeiffer and Jones (Janning, Scholtz, & Krehbiel, 2013). In these models, there are three steps: do, reflect, apply. Respondents seemed to recognize that the lessons build on those
concepts from learning to code to the end lesson of solving a real-world problem using drones. There were many ways that concept was adapted in each lesson as well where students experimented, reflected on the experiment through questions and discussion, and applied to real-world connections.

Kolb’s Experiential Learning Theory was also brought into use with the curriculum. The framework of the curriculum was designed to help youth learn through experiments. With the evaluation respondents rating 92% of the SOL concepts as extremely effective or very effective, it is clear that the concepts can be taught through the experiments and activities created in the curriculum. Life skills also received a significant response of extremely effective and very effective. Nearly 84% of those responses selected those top responses. This high scores similar to those for the SOL concepts supports the idea that these skills can be taught through activity.

Implications, Impacts, and Recommendations

The results of this evaluation will make a significant impact in completing and compiling this curriculum into something that can be used on a local, state, and national level. Based on the reactions and opinions of the participating respondents and the Situated Learning Theory, there is a definite correlation in using this curriculum to help reinforce SOL concepts and life skills. Overall in the SOL concept matrices, a total of 92 percent of the 612 choices were either “very effective” or “extremely effective.” None of the respondents chose “not effective at all” for any SOL concept or life skill which indicates that every SOL and life skill was reinforced in some way throughout the lesson whether in a large or small way. However, it is important to recognize that the expertise level of the respondents on SOL content is unknown. However, with the respondents being 4-H
Extension Agents and Specialists, there expertise on life skill can be confirmed. This may be a thought to consider on future research projects.

This response signifies the great impact this drone program potentially can have on youth participants. The evaluation respondents could see the value in the curriculum not only to reinforce SOL units and life skills but also as a hands-on, engaging program that will be educational and enjoyable. Though a small part of a bigger picture, a curriculum like this and others that follow may help students in the United States of America become more proficient in STEM topics and more competitive against others.

The length of the evaluation and “Drone the Unknown” curriculum may have contributed to a lower response rate than desired. Virginia Cooperative Extension houses 108 unit office across the state, and at any given time there is typically eighty to ninety 4-H Extension Agents active. Assuming ninety 4-H agents or specialists received the request for feedback, that equates to a 10% response rate. That estimate is most likely higher than the reality due to the number of College of Agriculture and Life Science faculty and staff who also may receive the emails. A higher response rate may have been received had the evaluation been shorter, but the details were all important to properly assessing the curriculum.

Another factor that could increase the response rate is the length of time the evaluation was open. Due to time constraints, the evaluation could only be held open over a two-week period. A reminder was sent out towards the closing of the evaluation that helped push a final response from agents.

To take this study further, the researcher recommends evaluating the level of change in understanding of SOL concepts and life skill development on the youth
participating in the “Drone the Unknown” program. By measuring the success of the youth participating in the program, a greater impact can be shown on the participants and their understanding of STEM concepts. To take it further, comparing the change amongst different grade levels would be an added recommendation. A study along those lines would require a great deal of data and much effort to promote the program. As a long term goal, a researcher could find how and if the program led to an increased outcomes related to career choices around the STEM field.

In addition, a piece that could be added to the evaluation is the objectives. Each lesson lists four or more objectives of the lesson. It would be beneficial to have those objectives evaluated to see if they are truly met within the lesson. This was a piece that easily could have been added to this evaluation piece but was overlooked.

Based on feedback from the participants, there are few but definite changes that need to be made. First, a review of the first lesson needs to be completed to rework the SOL correlations. This lesson had the most significant number of responses at “moderately effective.” Nearly 20% of the respondents in this lesson said a SOL unit was “moderately effective” or “slightly effective” compared to the other lessons which saw a maximum of 6% with those responses.

In addition, a more elaborate manual for teachers and educators needs to be made to better explain the program. While some were easily able to understand the concepts, others were not as comfortable. A manual will help explain concepts more thoroughly and in plain English for those who were not as experienced as some of the STEM people.
As for the life skills, at least three need to be better expressed in the curriculum: service learning, personal safety, and self-esteem. Service learning should be removed as a life skill developed through the curriculum as it was unclear where the curriculum addressed this topic. As for personal safety, a clearer defined section in each lesson should be added to remind participants and instructors of the need of safety gear and the ground rules for the program. There could also be an added area for students to check off on the individual worksheets.

Dissemination Plan

The information from this evaluation study will be uploaded into the VTechWorks publication center where students publish their thesis work.

In time, it is hoped that the curriculum piece will be published through Virginia Tech and the National 4-H Council. In order to accomplish these tasks, the curriculum developer will need to review the suggested changes such as adding a leader’s guide as a supplemental piece to the curriculum itself. Also, some of the SOL concepts and life skills which received the lowest ratings need to be removed or the curriculum needs to be adjusted to better show these concepts and skills.

Once these changes are made, the curriculum will need to be written in the newly created publication template for a faster peer-approval process. Peer-reviewers will be selected including at least one extension personnel from another state. Depending on the number of changes requested from that process, the curriculum developer will make the recommended changes and then publish the curriculum as a Virginia Cooperative Extension Publication.
Since the curriculum being a very technology based, it will be created as a VCE interactive publication or an “enhanced digital publication” available through an internet connection (Enhanced Digital Publications Reader Experience: A Video Walk-Through, 2018). This is a new concept for extension publications. Through these digital publications, participants can click through a table of contents, quickly search the publication, and share the document. Certain spaces on the publication can be interactive by including a link to another site, an audio clip, or a video with more information to name a few examples (Enhanced Digital Publications Reader Experience: A Video Walk-Through, 2018). These options can add a great deal of additional information and resources to supplement the curriculum. Another great benefit is that it is mobile friendly. Users can access these publications from a phone or tablet, and in this curriculum tablets are already being used.

In addition to these more professional settings, the 4-H faculty across the state will receive a short version of the compiled feedback for their usage. That way faculty members can decide if using the curriculum will be beneficial to their programs. It will also serve to garner support from 4-H faculty to potentially help with the publication process or other projects in the future.

References

4-H National Youth Science Day. (2018). Retrieved from 4-H: https://4-h.org/parents/national-youth-science-day/?gclid=EAIaIQobChMIInLCisaCT3wlVARgMCh1-cAHIEAAYASAAEgLWtfD_BwE#!code-your-world


*What is 4-H?* (n.d.). Retrieved from 4-H: https://4-h.org/about/what-is-4-h/

Appendices

A. Drone the Unknown Curriculum

DRONE THE UNKNOWN
Introduction to Coding and Drones

Leaders Guidebook and Worksheets
VIRGINIA 4-H

Virginia Cooperative Extension
Virginia Tech • Virginia State University

INTRODUCTION TO CURRICULUM

Background
This curriculum is designed to familiarize participants with drone technology, its uses, and basic operations. The basis of these operations includes lessons on coding through multiple mediums and a general understanding of coding in the world today. The curriculum also addresses several Virginia Standards of Learning (SOL) Topics. There are a lot of unknowns about drones amongst youth, and this curriculum hopes to address that.

Introducing new technologies and the concepts that go with them is an important part of educating the future generations. Drones are a perfect example of a successful, innovative idea that has the potential to transform many industries and parts of our daily lives. This curriculum aims to expand the imagination of youth and get their gears going to solve simple to more daunting problems we face as a society. All the lessons in this guidebook can be adapted and adjusted to each classroom, but the core of the lessons should stay the same. With youth being the inventors of the future, the hope is to show them what they can accomplish using their own ideas and working as a team.

The curriculum is designed to be used as a school enrichment program, but could be adapted as a 4-H SPIN club. An estimated time allotment is added to each lesson but may change based on class size and class ability. More or less time may be needed in those situations. The estimated total time for completion of the program is 7 hours.

Virginia Standards of Learning (SOLs)

Science
4.1: The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
   a) distinctions are made among observations, conclusions, inferences, and predictions;
   c) appropriate instruments are selected and used to measure length, mass, volume, and temperature in metric units;
   d) appropriate instruments are selected and used to measure elapsed time;
   e) predictions and inferences are made, and conclusions are drawn based on data from a variety of sources;
4.2: The student will investigate and understand characteristics and interactions of moving objects. Key concepts include
   a) motion is described by an object’s direction and speed;
   b) changes in motion are related to force and mass;
   c) friction is a force that opposes motion; and
   d) moving objects have kinetic energy.
5.1: The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
   c) estimates are made and accurate measurements of elapsed time are made using proper tools;
   i) inferences are made and conclusions are drawn.
6.1: The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
   b) precise and approximate measurements are recorded.
6.2: The student will investigate and understand basic sources of energy, their origins, transformations, and uses. Key concepts include
   a) potential and kinetic energy;

**Math**
4.4: The student will
   b) estimate and determine sums, differences, and products of whole numbers;
   d) create and solve single-step and multistep practical problems involving addition, subtraction, and multiplication, and single-step practical problems involving division with whole numbers.
4.6: The student will
   a) add and subtract with decimals; and
   b) solve single-step and multistep practical problems involving addition and subtraction with decimals.
4.7: The student will solve practical problems that involve determining perimeter and area in U.S. Customary and metric units.
5.1: The student, given a decimal through thousandths, will round to the nearest whole number, tenth, or hundredth.
5.4: The student will create and solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of whole numbers.
5.8: The student will
   a) solve practical problems that involve perimeter, area, and volume in standard units of measure; and
   b) differentiate among perimeter, area, and volume and identify whether the application of the concept of perimeter, area, or volume is appropriate for a given situation.

**Computer Technology**
3-5.1: Demonstrate an operational knowledge of various technologies.
   A. Use various types of technology devices to perform learning tasks.
      • Use a keyboard, mouse, touchscreen, touchpad, and other input devices to interact with a computer.
      • Demonstrate the ability to perform a wide variety of basic tasks using technology, including saving, editing, printing, viewing, and graphing.
   B. Communicate about technology with appropriate terminology.
      • Use basic technology vocabulary in daily practice.
3-5.2: Identify and use available technologies to complete specific tasks
   B. Use content-specific tools, software, and simulations to complete projects.
      • Use tools in various content areas as directed by the teacher.
6-8.1: Demonstrate an operational knowledge of various technologies.
   A. Use various types of technology devices to perform learning tasks.
      • Demonstrate the ability to perform specific tasks using technology, including
        organizing, analyzing, and presenting data; formatting and presenting text and graphic
        information; and capturing and manipulating images.
   B. Communicate about technology with appropriate terminology.
      • Use technology vocabulary in daily practice.

6-8.2: Identify and use available technologies to complete specific tasks.
   A. Identify the specific uses for various types of technology and digital resources.
      • Explain how various careers incorporate technology.
   B. Use content-specific tools, software, and simulations to complete projects.
      • Use tools in various content areas, such as graphing calculators, science simulations,
        story diagramming applications, image processing applications, and history timeline
        applications.

**Computer Science**

4.1: The student will construct sets of step-by-step instructions (algorithms) both independently
   and collaboratively
   a) using sequencing;
   b) using loops;
4.3: The student will analyze, correct, and improve (debug) an algorithm that includes
   sequencing, events, loops and variables.
4.15: The student will give examples of computing technologies that have changed the world and
   express how those technologies influence, and are influenced by, cultural practices.
5.15: The student will evaluate and describe the positive and negative impacts of the
   pervasiveness of computers and computing in daily life (e.g., downloading videos and audio files,
   electronic appliances, wireless Internet, mobile computing devices, GPS systems, wearable
   computing).
6.12: The student will explore careers related to data.

**4-H Life Skills**

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<thead>
<tr>
<th>Leadership</th>
<th>Teamwork</th>
<th>Self-Responsibility</th>
<th>Critical Thinking</th>
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<tbody>
<tr>
<td>Problem Solving</td>
<td>Decision Making</td>
<td>Service Learning</td>
<td>Planning or Organizing</td>
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<td>Wise Use of Resources</td>
<td>Communication</td>
<td>Cooperation</td>
<td>Conflict Resolution</td>
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<tr>
<td>Sharing</td>
<td>Self Esteem</td>
<td>Contribution to group</td>
<td>Marketable/useful skills</td>
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<tr>
<td>Personal Safety</td>
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Before You Start
Before jumping into this curriculum, it is important that one understands the concepts presented in this guidebook.

Drones or Unmanned Aerial Vehicles (UAVs): a remote-controlled or autonomously flown through software-controlled flight plans, pilotless aircraft or robot

Coding: the primary method for communication between humans and machines; the process of sequencing instructions for a computer to understand to perform certain functions

Federal Aviation Agency (FAA): regulating agency of all aspects of civil aviation

Sprite/Actor:

In addition to the terminology, please make sure you read the regulations outlined by the FAA on their website.

Safety Precautions:

1. Provide eye protection to all participants if available.
2. Establish an area where drones can be flown that is away from potential passersby.
3. Require youth to wait behind a line that is safely away from the drone path when drones are on the course.
4. Do not allow participants to touch drones while in the air.
5. Fly one drone at a time.
6. Let school or building administration aware of the program ahead of time.
LESSON 1: CODING 101

Objectives
- Develop a basic understanding of coding
- Learn how to create a sequence of events
- Learn the functions of the coding system
- Understand how drones can be used

Life Skills
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SOL Correlation
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<tr>
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<td>3-5.1, 3-5.2, 6-8.2</td>
<td>4.1, 4.3, 4.15, 5.1, 6.12</td>
</tr>
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</table>

Time Required: 1 hour

Supply List
- Computers with internet access OR iPads with the app Tynker

Background Information and Procedure
- Students will be discussing coding and the various uses
- Students will get to write our own codes to create a specific sequence of events
- Students will learn how these codes are used in real life

OPTIONAL Get Acquainted Activity:

Begin by asking students if they know what the term “coding” means? Some may mention video games or computers. Make sure participants understand that our phones, tablets, electronics are coded to each individual button/action. For example, when typing on a phone or tablet, each letter is programmed to be the correct letter. Each application is programmed to do specific tasks. These codes are much longer and more complicated than the codes we will be creating, but it is good to start somewhere.

In this activity, students should be put in groups of two or three.

1. Set up a simple obstacle course.

6
2. In the groups, students should write step-by-step directions for their group member to successfully walk through the obstacle course. Emphasize to students the importance of making specific and clear directions. Use worksheet 1.1 to help guide students.

3. After the students have completed their codes, collect the instructions and have the students one by one go through the course as you read the code exactly as written.

More than likely, students will have left some important steps for their group member to follow, and the rest of the course is changed because of the one error. Explain to them that this is what happens with coding and that is why it is important to be specific and include each step.

Explain to the class that they will be using computers or iPads to learn the basics of coding. Coding is the basic process programmers use when creating programs. When you play video games or use apps on your phone or tablet, those programs are creating by coding. Every button has a certain functionality to it, and coding is used to assign those functions.

1. After explaining what coding is and its purpose in the various functions of society, ask students the following questions:
   a. What sort of things they use that involve coding?
   b. Have you ever coded any programs before?
   c. What kind of job might require you to code?
   d. How does coding relate to drones?

2. Tell students that they will get the opportunity to practice coding during this short course. Students will be starting by using various computer programs to make objects or sprites/actors on their screen perform certain tasks from simply moving across the screen to making an interactive game.

3. Define a sprite or actor as the character that will be receiving the code created by the user. Then use the remaining steps for either computers or iPads.

**Instructions for Students on Computers:**

4. Go to scratch.mit.edu to open the online coding system. It is a good idea to familiarize yourself with the app ahead of time.

5. Have students watch a short video on the homepage of the website to give them an idea of the various options available. They can also watch examples.

6. Have students complete worksheet 1.2.

7. When complete, let students experiment with creating their own projects as long as time allows.
OR Instructions for Students on iPads:

4. Make sure all iPads are fully charged and have the Tynker app downloaded. It is a good idea to familiarize yourself with the app ahead of time.
5. Open the app and have students click the “Projects” button.
6. Hit “Create New Project” then select “New Project” and a character will appear on a gridded screen. Select the “<>/” to get to the coding screen.
7. Have students complete worksheet 1.1.
8. When complete, let students experiment with creating their own projects as long as time allows.
THE ROAD TO CODE

Worksheet 1.1: Practicing Coding with Friends

Name: ____________________________ Date: ____________

Partner(s): ________________________

Write a code for a partner to follow to complete the task at hand. Be specific in your instructions as your partner will have to follow the steps exactly as written.

1. ___________________________________
2. ___________________________________
3. ___________________________________
4. ___________________________________
5. ___________________________________
6. ___________________________________
7. ___________________________________
8. ___________________________________
9. ___________________________________
10. ___________________________________
11. ___________________________________
12. ___________________________________
13. ___________________________________
14. ___________________________________
15. ___________________________________

Was your partner able to complete the task successfully?

What would you do differently?
THE ROAD TO CODE

Worksheet 1.2: Practicing Coding

Name:_________________________ Date:___________

1. Make your sprite/actor move from the middle to the end of the screen by following the code below. Describe what happened to your character below.

![Code block]

2. Add an additional script to your sprite/actor to make the code interactive. What happened when you added this script?

![Code block]

3. Practice having your sprite/actor move from one point to another and have it rotate. Write your code below.

4. Get creative! Add a backdrop and second sprite to your code. Make them move and change color. Write your code below.
LESSON 2: KNOW THE DRONE

Objectives
- Learn to make predictions
- Learn to take measurements on complex objects
- Understand proper measuring terms
- Understand potential and kinetic energy
- Learn to connect coding to drones

Life Skills
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Computer Science
4.1, 4.3, 5.1

Time Required: 60-90 minutes

Supply List
- Drones (enough for 5 students max per drone)
- Rulers (at least one per group)
- Paper or Notepads
- Start and Finish Markers
- Timer
- Tape (as a safety line) or some sort of marker for students to stay behind
- Object weighing 16 ounces
- Optional: String tied to any heavy object (water bottle, ball, etc.)
- Optional: Obstacles (chairs, boxes, tables, hula hoops, etc.)

Background Information and Procedure
- Before beginning the lesson, be sure to weigh the drone in ounces.
- In this lesson students are going to put our coding skills to the test and code a drone to fly from point A to point B
- Students will work in teams to measure the size of the drone and make predictions of its weight
- Students will estimate how long it takes the drone to get from point A to point B
- Remind students that an important part of today’s activity is personal safety
- Explain to students that every drone is different and one small difference can make a big change to the drone’s path
- Ask students what they think might cause variation in the drone’s path despite using the same code and starting in the same spot (i.e. – wind, weight changes, bent parts, battery power, etc.)

1. Assign students to teams. You may want to have this decided ahead of time depending on your classroom and the number of drones available.
2. Set up a course that can easily has a clearly marked starting area and a landing pad for students to aim their drone to land.
3. Before handing out the materials for the day, review terms with your students.
   a. Ask how can you determine the perimeter of an object? The area?
   b. What is the radius in a circle? Diameter?
   c. What is a hypothesis?
   d. What two kinds of energy exist in the world?
   e. What are the differences in potential and kinetic energy?
   f. Optional: Using an object tied to the string, demonstrate potential and kinetic energy by making a pendulum with object and string.
4. Have the students complete Worksheet 2.1. At this time, it is a good idea to get your drones connected to the iPads. Each team will receive a drone and iPad to complete worksheet 2.1.
5. After completing the worksheet, students should begin writing the code to successfully make the drone fly the course. If time allows, change the course and add obstacles to give students a chance to experiment with different codes.

Apply: Ask the students the following questions:
- What is a perimeter?
- How is the area determined?
- How did you determine how far the drone would go in nine seconds without flying the drone for that period of time? Define inference for students.
- How could drones be used to complete a task? What would you use your drone for?
GETTING TO KNOW YOUR DRONE

Worksheet 2.1: Get to Know Your Drone

Team Members: ___________________________ Team Number: ________________
______________________________
______________________________
______________________________

Team Name: ___________________________ ___________________________

1. Measure the following parts of your drone in inches:
   a. Perimeter of Drone: _________
   b. Area of Drone: _____________
   c. Radius of Propeller: __________

2. Estimate the weight of your drone in ounces by comparing weight to 16 ounces: _______

3. How far does your drone travel when flying for the following times:
   a. One second: ___________
   b. Three seconds: _______

4. How far would you estimate your drone to travel after nine seconds? Explain.

5. What kind of energy is used when the drone is flying? ___________________________

6. What kind of energy would be found in the drone’s battery? ___________________________

THINK ABOUT IT: Do you think adding weight to your drone will affect how it flies? Why or Why not?

7. Now, work as a team to successfully make your drone fly from point A to point B. Use the answers above to determine how many seconds the drone needs to fly.
LESSON 3: DRONES THAT DELIVER

Objectives
- Learn to make predictions
- Learn to take accurate measurements
- Make real life connections
- Learn to design, build, and test a product
- Use creativity in designing delivery mode

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Computer Science
4.1, 4.2, 4.15, 5.1, 6.12

Time Required: 60-90 minutes

Supply List
- Drones (enough for 5 students max per drone)
- Rulers (at least one per group)
- Scales
- Paper or Notepads
- Start and Landing Markers
- Various paper, bags, string, egg cartons that can be used to create a delivery mode
- Scissors
- Tape
- Monopoly pieces or Lego characters
- Optional: 3D Pens or Printer
**Background Information and Procedure**

- In this lesson, students are going to put our engineering skills to design a mechanism that will carry an object from Point A to Point B. In addition to the challenge of creating a design, teams will also be challenged to code the drone to Point B, drop off their "package" and return to Point A.
- Courses should be simple as the focus is successfully making a delivery mode, not coding; coding is still, however, and important piece.
- Each team should be given an object to deliver. It should be something small like a Lego character or monopoly piece.
- Ask the students to think about their last assignment. How far did their drone go in 1 second; in 3 seconds? Will it be important to measure the distance from point A to point B in order to determine how many seconds to have the drone fly?
- Continue the activity following the set of questions on Worksheet 3.1. Make sure you approve the design of the delivery system before they begin to build. *Optional: If you have access to a 3D printer or 3D Pens, make a system using that technology. This may add significant time to this activity.

**Apply:** After the activity is complete, ask the students the following questions:

- How did the weight of their design will affect the drone’s ability to fly?
- How would this be helpful in real world scenarios?
- What was the most challenging in this activity?
- What would you do differently if you could do it again?
DISCOVERING DELIVERY

Worksheet 3.1: Design and Delivery
Team Members: ____________________________  Team Number: ________________
____________________________            Team Name: _______________________
____________________________

Draw a design for your delivery system in the space below.

Product Mass: ______   Product Perimeter: ______   Product Area: ______

Trial 1:
Did your design work? _______    Why or Why not? ____________________________
What will you change if anything? ____________________________

Trial 2:
Did your design work? _______    Why or Why not? ____________________________
What will you change if anything? ____________________________

Trial 3:
Did your design work? _______    Why or Why not? ____________________________
What will you change if anything? ____________________________

THINK ABOUT IT: How could you make your package land without damaging it?
LESSON 4: DROP ZONE DRONES

Objectives
- Learn to make predictions
- Learn to take accurate measurements
- Make real life connections
- Learn to design, build, and test a product
- Use creativity in designing parachutes

Life Skills
Teamwork Critical Thinking Decision Making Planning or Organizing
Communication Cooperation Conflict Resolution Sharing Self Esteem
Marketable Skills Personal Safety Leadership Contribution to Group
Wise Use of Resources Self-Responsibility

SOL Correlation
Science Math Computer Technology
4.1, 4.2, 5.1, 6.1 4.4, 4.6, 4.7, 5.1, 5.4, 5.8 3-5.1, 3-5.2, 6-6.2

Computer Science
4.1, 4.3, 5.1

Time Required: 60-90 minutes

Supply List
- Drones (enough for 5 students max per drone)
- Rulers (at least one per group)
- Scales
- Paper or Notepads
- Start and Finish Markers
- Various paper, bags, string, egg cartons that can be used to create a delivery mode
- Lego character or Monopoly game piece
- Scissors
- Tape
- Optional: 3D Pens
Background Information and Procedure

- Students will be creating a way to safely drop our packages.
- Ask students to share ways that this may be possible.
- Depending on the size of your drone, you can use a Lego character or a Monopoly game piece as the object, or if using a larger drone, incorporate the egg drop project into the challenge.
- Have ample supplies available for students to use in their design, but ask them to draw the design first and have it approved before beginning the building process.
- Students should aim to create a design that makes a parachute system of sorts. Drones will need to be coded to fly up about 25 feet and drop the structure OR have a teacher fly the drone up to the same distance and release the structure. Students should aim to have the longest hang time.
- Explain to students that the longest hang time will be determined by taking the average time over 3 trials.
- Have the students complete Worksheet 4.1.

Apply: After the activity, ask the follow questions:

- How did the weight of their design will affect the landing?
- How would this be helpful in real world scenarios?
- What was the most challenging in this activity?
- What would you do differently if you could do it again?
THE PERFECT LANDING

Worksheet 4.1: Drop Zone Drones

Team Members: ___________________________  Team Number: ________________

_________________________  Team Name: ___________________________

_________________________

Draw a design for your landing system in the space below.

Product Mass: ______  Product Perimeter: _____  Product Area: ______

Trial 1:

Time from drop to landing: ______  Did your design work? ________  Why or Why not?

___________________________________________

What will you change if anything? ____________________________________________

Trial 2:

Time from drop to landing: ______  Did your design work? ________  Why or Why not?

___________________________________________

What will you change if anything? ____________________________________________

Trial 3:

Time from drop to landing: ______  Did your design work? ________  Why or Why not?

___________________________________________

What will you change if anything? ____________________________________________

Average time in air (trial 1 time + trial 2 time + trial 3 time / 3): _____________

THINK ABOUT IT: How could drones be used in jobs and industries?
LESSON 5: DRONES IN ACTION

Objectives
- Make real life connections
- Use creativity in designing new drone uses
- Explore jobs and careers that use drones
- Understand how drones and technology can make jobs more efficient and safe

Life Skills
<table>
<thead>
<tr>
<th>Teamwork</th>
<th>Critical Thinking</th>
<th>Decision Making</th>
<th>Planning or Organizing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication</td>
<td>Cooperation</td>
<td>Conflict Resolution</td>
<td>Sharing</td>
</tr>
<tr>
<td>Marketable Skills</td>
<td>Personal Safety</td>
<td>Problem Solving</td>
<td>Leadership</td>
</tr>
<tr>
<td>Self-Responsibility</td>
<td>Contribution to group</td>
<td></td>
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</tbody>
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SOL Correlation
<table>
<thead>
<tr>
<th>Computer Technology</th>
<th>Computer Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-5.1, 3-5.2, 6-6.2</td>
<td>4.15, 6.12</td>
</tr>
</tbody>
</table>

Time Required: 60-90 minutes

Supply List
- Poster Board
- Markers
- Timer

Background Information and Procedure
- Today we are going to talk about drones in the real world and why they can be useful in efficiency and safety in various industries.
- *Optional: Invite professionals from various industries (agriculture, forestry, emergency services, utilities, distribution, search and rescue, etc.) to speak about their industry with drones and/or bring professional grade drones.
- Start a discussion with the class. Ask them what they think current issues are in their community or across the globe. You may have to define current issues and give some examples. Talk about major events you see/hear on the news.
- Tell the students that they will be working in their teams to pick one of these current issues or problems and figure out a way a drone could help resolve or lessen the occurrence of an issue.

- When students have grasped the idea, have them complete Worksheet 5.1 in their teams and then conduct a short presentation.

- Discuss ways to make a proper presentation:
  - Every team member should speak
  - They should all come to one idea together as a team
  - Include an introduction to the problem, drone design, how drones can help solve or lessen the problem, and a conclusion
  - Providing a visual of their drone idea is suggested but not required
  - Presentations should be at least 2 minutes
REAL PROBLEMS, REAL SOLUTIONS

Worksheet 5.1: Drones in Action

Team Members: ___________________________ Team Number: ________________

Team Name: ____________________________

In this activity, you are going to work with team members to solve a real world problem using drones. This may be a problem in your community or a global issue. Your drone can do anything you imagine it to do to help solve or lessen a problem. It can be a safety, efficiency, environment problem just to name a few. Use your imagination.

1. State your problem: ___________________________

2. State your solution using drones: ___________________________

Draw a design for your new drone in the space below or on provided poster board.

3. Prepare a short presentation on your new drone. Everyone on your team should speak. Follow this layout to help make your presentation:
   - Introduction of problem, Your drone design, How the drone will help solve or lessen problem, Conclusion
B.
Evaluation of Curriculum from Qualtrics
Block 1

Use the button below to download a PDF of the "Drone the Unknown" curriculum. Each section in the evaluation is divided by lesson. It is recommended to print the PDF for easier viewing of the questions while viewing the curriculum.

Drone the unknown

Please rate the following on the effectiveness of the “Drone the Unknown” **Lesson 1:** **Coding 101** to reinforce the following Virginia SOLs.

| Science 4.1 – The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science. |
|---------------|-------------------------------------------------|---|---|---|---|---|
| Extremely effective | Very effective | Moderately effective | Slightly effective | Not effective at all |
| ○ | ○ | ○ | ○ | ○ |

| Science 5.1 - The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which estimates are made and accurate measurements of elapsed time are made using proper tools; inferences are made and conclusions are drawn. |
|---------------|-------------------------------------------------|---|---|---|---|---|
| Extremely effective | Very effective | Moderately effective | Slightly effective | Not effective at all |
| ○ | ○ | ○ | ○ | ○ |

| Science 6.1 - The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which precise and approximate measurements are recorded. |
|---------------|-------------------------------------------------|---|---|---|---|---|
| Extremely effective | Very effective | Moderately effective | Slightly effective | Not effective at all |
| ○ | ○ | ○ | ○ | ○ |
Math 4.4 - The student will estimate and solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of whole numbers.

Math 5.4 - The student will create and solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of whole numbers.

Computer Technology 3-5.1 – Demonstrate an operational knowledge of various technologies (drones, iPads, computers, etc).

Computer Technology 3-5.2 – Identify and use available technologies to complete specific tasks.

Computer Technology 6-8.2 – Identify and use available technologies to complete specific tasks.

Computer Science 4.1 – The student will construct sets of step-by-step instructions (algorithms) both independently and collaboratively.

Computer Science 4.3 – The student will analyze, correct, and improve (debug) an algorithm that includes sequencing, events, loops and variables.

Computer Science 4.15 - The student will give examples of computing technologies that have changed the world and express how those technologies influence, and are influenced by, cultural practices.

Computer Science 5.1 – The student will construct sets of step-by-step instructions (algorithms) both independently and collaboratively.

Computer Science 6.12 - The student will explore careers related to data.
What improvements can be made to Lesson 1: Coding 101?

What did you like about Lesson 1: Coding 101?

Please rate the following on the effectiveness of the “Drone the Unknown” Lesson 2: Know the Drone to reinforce the following Virginia SOLs.

Science 4.1 – The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science.

Science 4.2 - The student will investigate and understand characteristics and interactions of moving objects.

Science 5.1 - The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which estimates are made and accurate measurements of elapsed time are made using proper tools; inferences are made and conclusions are drawn.

Science 6.1 - The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which precise and approximate measurements are recorded.
and understand basic sources of energy, their origins, transformations, and uses. Key concepts include potential and kinetic energy.

Math 4.4 - The student will estimate and determine sums, differences, and products of whole numbers and create and solve single-step and multistep practical problems involving addition, subtraction, and multiplication, and single-step practical problems involving division with whole numbers.

Math 4.6 - The student will add and subtract with decimals; and solve single-step and multistep practical problems involving addition and subtraction with decimals.

Math 4.7 - The student will solve practical problems that involve determining perimeter and area in U.S. Customary and metric units.

Math 5.1 - The student, given a decimal through thousandths, will round to the nearest whole number, tenth, or hundredth.

Math 5.4 - The student will create and solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of whole numbers.

Math 5.8 - The student will solve practical problems that involve perimeter, area, and volume in standard units of measure; and differentiate among perimeter, area, and volume and identify whether the application of the concept of perimeter, area, or volume is appropriate for a given situation.

Computer Technology 3-5.1 – Demonstrate an operational knowledge of various technologies (drones, iPads, computers, etc).

Computer Technology 3-5.2 - Identify and use available technologies to complete specific tasks.

<table>
<thead>
<tr>
<th>Extremely effective</th>
<th>Very effective</th>
<th>Moderately effective</th>
<th>Slightly effective</th>
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12/1/2018

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<thead>
<tr>
<th>Qualtrics Survey Software</th>
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Computer Science 4.1 – The student will construct sets of step-by-step instructions (algorithms) both independently and collaboratively.

Computer Science 4.3 – The student will analyze, correct, and improve (debug) an algorithm that includes sequencing, events, loops and variables.

Computer Science 5.1 – The student will construct sets of step-by-step instructions (algorithms) both independently and collaboratively.

What improvements can be made to Lesson 2: Know the Drone?

What did you like about Lesson 2: Know the Drone?

Please rate the following on the effectiveness of the “Drone the Unknown” Lesson 3: Drones that Deliver to reinforce the following Virginia SOLs.

Science 4.1 – The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science.
and understand characteristics and interactions of moving objects.

Science 5.1 - The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which estimates are made and accurate measurements of elapsed time are made using proper tools; inferences are made and conclusions are drawn.

Science 6.1 - The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which precise and approximate measurements are recorded.

Math 4.4 - The student will estimate and determine sums, differences, and products of whole numbers and create and solve single-step and multistep practical problems involving addition, subtraction, and multiplication, and single-step practical problems involving division with whole numbers.

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Math 4.7 - The student will solve practical problems that involve determining perimeter and area in U.S. Customary and metric units.

Math 5.1 - The student, given a decimal through thousandths, will round to the nearest whole number, tenth, or hundredth.

Math 5.8 - The student will solve practical problems that involve perimeter, area, and volume in standard units of measure; and differentiate among perimeter, area, and volume and identify whether the application of the concept of perimeter, area, or volume is appropriate for a given situation.
an operational knowledge of various technologies (drones, iPads, computers, etc).

Computer Technology 3-5.2 - Identify and use available technologies to complete specific tasks.

Computer Technology 6-8.2 - Identify and use available technologies to complete specific tasks.

Computer Science 4.1 – The student will construct sets of step-by-step instructions (algorithms) both independently and collaboratively.

Computer Science 4.3 – The student will analyze, correct, and improve (debug) an algorithm that includes sequencing, events, loops and variables.

Computer Science 4.15 – The student will give examples of computing technologies that have changed the world and express how those technologies influence, and are influenced by, cultural practices.

Computer Science 5.1 – The student will construct sets of step-by-step instructions (algorithms) both independently and collaboratively.

Computer Science 6.12 - The student will explore careers related to data.

What improvements can be made to Lesson 3: Drones that Deliver?

What did you like about Lesson 3: Drones that Deliver?
Please rate the following on the effectiveness of the “Drone the Unknown” Lesson 4: Drop Zone Drones to reinforce the following Virginia SOLs.

Science 4.1 – The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science.

Science 4.2 - The student will investigate and understand characteristics and interactions of moving objects.

Science 5.1 - The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which estimates are made and accurate measurements of elapsed time are made using proper tools; inferences are made and conclusions are drawn.

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Computer Technology 3-5.1 – Demonstrate an operational knowledge of various technologies (drones, iPads, computers, etc).

Computer Technology 3-5.2 - Identify and use available technologies to complete specific tasks.

Computer Technology 6-8.2 - Identify and use available technologies to complete specific tasks.

Computer Science 4.1 – The student will construct sets of step-by-step instructions (algorithms) both independently and collaboratively.

Computer Science 4.3 – The student will analyze, correct, and improve (debug) an algorithm that includes sequencing, events, loops and variables.

Computer Science 5.1 – The student will construct sets of step-by-step instructions (algorithms) both independently and collaboratively.

What improvements can be made to Lesson 4: Drop Zone Drones?
What did you like about Lesson 4: Drop Zone Drones?

Please rate the following on the effectiveness of the “Drone the Unknown” Lesson 5: Drones in Action to reinforce the following Virginia SOLs.

<table>
<thead>
<tr>
<th>SOL Description</th>
<th>Extremely effective</th>
<th>Very effective</th>
<th>Moderately effective</th>
<th>Slightly effective</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Computer Technology 3-5.1 – Demonstrate an operational knowledge of various technologies (drones, iPads, computers, etc).</td>
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<tr>
<td>Computer Technology 3-5.2 - Identify and use available technologies to complete specific tasks.</td>
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<tr>
<td>Computer Technology 6-8.2 - Identify and use available technologies to complete specific tasks.</td>
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</tbody>
</table>

What improvements can be made to Lesson 5: Drones in Action?

What did you like about Lesson 5: Drones in Action?
Please rate the following on the effectiveness of the “Drone the Unknown” curriculum to addressing the following life skills.

<table>
<thead>
<tr>
<th></th>
<th>Extremely effective</th>
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</tr>
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<tbody>
<tr>
<td>Teamwork</td>
<td>◯</td>
<td>◯</td>
<td>◯</td>
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<tr>
<td>Self-Responsibility</td>
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<tr>
<td>Critical Thinking</td>
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<td>Problem Solving</td>
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<td>Decision Making</td>
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<td>Service Learning</td>
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<td>Wise Use of Resources</td>
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<td>Contribution to a group</td>
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<td>Personal Safety</td>
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<td>Self Esteem</td>
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<tr>
<td>Leadership</td>
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</tbody>
</table>

How does the curriculum bring the real-world application to youth? Check all that apply.

- □ Connection of coding as the basis of all technology
- □ Using drones for efficiency
- □ Using drones for increased safety
- □ Coding as a marketable skill
- □ Introduction to career opportunities
- □ Using drones for increased safety
- □ Usage of drones in real life situations
- □ Evolution of technology
- □ Increased interest in STEM activities

What changes do you think would improve this curriculum?

What things did you like about the curriculum?
C.

Life Skills Wheel

(Hendricks, 1996)
**D.**

**Evaluation Results Charts**

**Q1 - Please rate the following on the effectiveness of the “Drone the Unknown” Lesson 1: Coding 101 to reinforce the following Virginia SOLs.**

<table>
<thead>
<tr>
<th>Question</th>
<th>Extremely effective</th>
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<th>Moderately effective</th>
<th>Slightly effective</th>
<th>Not effective at all</th>
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</thead>
<tbody>
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<td><strong>Science 4.1 – The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science.</strong></td>
<td>22.22%</td>
<td>66.67%</td>
<td>11.11%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td><strong>Science 5.1 - The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which estimates are made and accurate measurements of elapsed time are made using proper tools; inferences are made and conclusions are drawn.</strong></td>
<td>55.56%</td>
<td>22.22%</td>
<td>22.22%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td><strong>Science 6.1 - The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which precise and approximate</strong></td>
<td>44.44%</td>
<td>44.44%</td>
<td>11.11%</td>
<td>0.00%</td>
<td>0.00%</td>
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</tbody>
</table>
measurements are recorded.

| Math 4.4 - The student will estimate and determine sums, differences, and products of whole numbers and create and solve single-step and multistep practical problems involving addition, subtraction, and multiplication, and single-step practical problems involving division with whole numbers. |
|---|---|---|---|---|---|---|---|---|
| 11.11% | 1 | 33.33% | 3 | 55.56% | 5 | 0.00% | 0 | 0.00% | 0 |

| Math 5.4 - The student will create and solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of whole numbers. |
|---|---|---|---|---|---|---|---|---|
| 33.33% | 3 | 11.11% | 1 | 44.44% | 4 | 11.11% | 1 | 0.00% | 0 |

| Computer Technology 3-5.1 – Demonstrate an operational knowledge of various technologies (drones, iPads, computers, etc). |
|---|---|---|---|---|---|---|---|---|
| 77.78% | 7 | 22.22% | 2 | 0.00% | 0 | 0.00% | 0 | 0.00% | 0 |

| Computer Technology 3-5.2 - Identify and use available technologies to complete specific tasks. |
|---|---|---|---|---|---|---|---|---|
| 88.89% | 8 | 11.11% | 1 | 0.00% | 0 | 0.00% | 0 | 0.00% | 0 |

<p>| Computer Technology 6-8.2 - Identify and use available |
|---|---|---|---|---|---|---|---|---|
| 88.89% | 8 | 11.11% | 1 | 0.00% | 0 | 0.00% | 0 | 0.00% | 0 |</p>
<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Percentages</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Computer Science 4.1</strong></td>
<td>The student will construct sets of step-by-step instructions (algorithms) both independently and collaboratively.</td>
<td>55.56%</td>
<td>5</td>
</tr>
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Q2 - What improvements can be made to Lesson 1: Coding 101?

Include job shadowing and internship on some level with industry professionals

It would be neat if there was a way to connect this lesson to a video game or current technology that the youth regularly use. It would also be really cool if you could get Microsoft or another coding company to come into the classroom to teach the students how these lessons relate to their daily jobs.

I think one way to improve the Lesson 1 would be to provide examples for at least trouble shooting for the instructor. I think that an example of each lesson would help them with understanding how to guide the students if they aren’t as comfortable with the two apps.

Often youth involved in a program which incorporates some sort of technology will be disappointed (less willing to engage) if they aren't able to see/touch/get their hands on the actual item (in this case the drone). In reference to the careers sol, you aren’t teaching them about careers, you are activating prior knowledge about careers using code.

Q3 - What did you like about Lesson 1: Coding 101?

Very straight-forward, uses technology in a simple format. Have not used Tynker, but was able to code a simple program in Scratch.

User friendly

Seems very useable - easily understandable, easily taught, and not to many materials

I really liked how coding was explained and that the youth were exposed to real life examples of how coding is used in careers. I also liked that the youth had an opportunity at the end of the lesson to be creative and come up with their own project.

I love the tie in between the two activities! I think the IRL activity and the technology based activity work perfectly together!

Coding "practice" using youth is a great way to actively engage both the visual and kinesthetic learners. Adequate time given to explore scratch with specific activities that also encourage youth to follow directions and also explain what happened as a result. (worksheet 1.2)

Q4 - Please rate the following on the effectiveness of the “Drone the Unknown” Lesson 2: Know the Drone to reinforce the following Virginia SOLs.

<table>
<thead>
<tr>
<th>Question</th>
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<tbody>
<tr>
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<tr>
<td>Science 4.2 - The student will investigate and understand characteristics and interactions of moving objects.</td>
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<td>66.67%</td>
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<td>Science 5.1 - The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which estimates are made and accurate measurements of elapsed time are made using proper tools; inferences are made and conclusions are drawn.</td>
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<tr>
<td>Science 6.1 - The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which precise and approximate measurements are recorded.</td>
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<tr>
<td>Science 6.2 - The student will investigate and understand basic sources of energy, their origins, transformations, and uses. Key concepts</td>
<td>33.33%</td>
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<td>55.56%</td>
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</tbody>
</table>
include potential and kinetic energy.

<table>
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<tr>
<th>Math 4.4 - The student will estimate and determine sums, differences, and products of whole numbers and create and solve single-step and multistep practical problems involving addition, subtraction, and multiplication, and single-step practical problems involving division with whole numbers.</th>
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<tr>
<td>Math 4.7 - The student will solve practical problems that involve determining perimeter and area in U.S. Customary and metric units.</td>
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<td>Math 5.1 - The student, given a decimal through thousandths, will round to the nearest whole number, tenth, or hundredth.</td>
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<td>Math 5.4 - The student will create and solve single-step and multistep</td>
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practical problems involving addition, subtraction, multiplication, and division of whole numbers.

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<tr>
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will construct sets of step-by-step instructions (algorithms) both independently and collaboratively.

| Computer Science 4.3 – The student will analyze, correct, and improve (debug) an algorithm that includes sequencing, events, loops and variables. | 66.67% | 6 | 11.11% | 1 | 22.22% | 2 | 0.00% | 0 | 0.00% | 0 |

| Computer Science 5.1 – The student will construct sets of step-by-step instructions (algorithms) both independently and collaboratively. | 66.67% | 6 | 33.33% | 3 | 0.00% | 0 | 0.00% | 0 | 0.00% | 0 |

Q5 - What improvements can be made to Lesson 2: Know the Drone?

3a Ask how - better just "How"? 3b radius "of" a circle?

Include suggestions for resources to purchase drones and computers

Starting the youth out in teams is a great way to introduce this lesson. My only concern is making sure each youth in the team participates. How do you plan to make sure all youth are actively engaged? It would be nice to have specific tasks mentioned in the guidelines that tell the youth that each youth must have a role and must present on their role at the end of the program.

Is the only person most likely to use the curriculum a teacher? If a 4-H agent were to use it, I think it would be great to have an attached answers to the questions, or create a FAQ sheet that will help those who want to teach it, but are not experts. It could even be for a 3rd grade teacher that doesn't completely feel comfortable with the technology etc.

The instructions for use with students could be more clear. When will they have the drones, vs when will they fly them? ie-#3 on worksheet 2.1-- are they flying them or is the instructor? #7 is also a bit unclear as to how/when to operate the drone. You may also include an estimated area for the drone course in the supply list.
Q6 - What did you like about Lesson 2: Know the Drone?

- Hands-on with the drones in a guided activity.
- It’s something that kids will gravitate to.
- The worksheet was very well done and listed out exactly what the students needed to complete.
- Really neat lesson!
- This lesson is awesome! I love how well researched and tied to SOLs it is. It is thorough and flows extremely well!
- I like the worksheet for this lesson as well, but it needs the above questions answered for me.

Q7 - Please rate the following on the effectiveness of the “Drone the Unknown” Lesson 3: Drones that Deliver to reinforce the following Virginia SOLs.

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<td><strong>Science 4.1 – The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science.</strong></td>
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<td><strong>Science 4.2 - The student will investigate and understand characteristics and interactions of moving objects.</strong></td>
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</table>
Q8 - What improvements can be made to Lesson 3: Drones that Deliver?

Background, 2nd bullet, "an" important piece; not sure the 3D pens/printer option would be workable without more guidance. I would need access and instruction. Apply - design will—just design?

In the future, if heavier objects and larger drones could be used, it would be really cool to be able to show youth that.

I think adding a space for the redesign (if the teams do so in between trials) would help include more of the engineering design process and to make them think through trials and revisions.

I think a larger design space in worksheet 3.1 is needed. Half page, maybe?

Q9 - What did you like about Lesson 3: Drones that Deliver?

Integrated engineering design model without being too obvious.

Very interesting! I love that game board pieces and legos were used as carrying pieces during the activity.

Awesome lesson! Great fit to SOLs, but even more so to the engineering design process!

Having a specific challenge that builds on the skills that they have learned in lessons 1-2 is the best part of this lesson.

Q10 - Please rate the following on the effectiveness of the “Drone the Unknown” Lesson 4: Drop Zone Drones to reinforce the following Virginia SOLs.

<table>
<thead>
<tr>
<th>Question</th>
<th>Extremely effective</th>
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| Science 6.1 - The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which precise and approximate measurements are recorded. | 77.78% | 7 | 22.22% | 2 | 0.00% | 0 | 0.00% | 0 |

| Math 4.4 - The student will estimate and determine sums, differences, and products of whole numbers and create and solve single-step and multistep practical problems involving addition, subtraction, and multiplication, and single-step practical problems involving division with whole numbers. | 44.44% | 4 | 33.33% | 3 | 22.22% | 2 | 0.00% | 0 | 0.00% | 0 |

<p>| Math 4.6 - The student will add and subtract with decimals; and solve single-step and | 33.33% | 3 | 44.44% | 4 | 22.22% | 2 | 0.00% | 0 | 0.00% | 0 |</p>
<table>
<thead>
<tr>
<th>Math 4.7 - The student will solve practical problems that involve determining perimeter and area in U.S. Customary and metric units.</th>
<th>33.33%</th>
<th>3</th>
<th>55.56%</th>
<th>5</th>
<th>11.11%</th>
<th>1</th>
<th>0.00%</th>
<th>0</th>
<th>0.00%</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 5.1 - The student, given a decimal through thousandths, will round to the nearest whole number, tenth, or hundredth.</td>
<td>11.11%</td>
<td>1</td>
<td>55.56%</td>
<td>5</td>
<td>33.33%</td>
<td>3</td>
<td>0.00%</td>
<td>0</td>
<td>0.00%</td>
<td>0</td>
</tr>
<tr>
<td>Math 5.4 - The student will create and solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of whole numbers.</td>
<td>33.33%</td>
<td>3</td>
<td>44.44%</td>
<td>4</td>
<td>22.22%</td>
<td>2</td>
<td>0.00%</td>
<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>Math 5.8 - The student will solve practical problems that involve perimeter, area, and volume in standard units of measure; and differentiate among perimeter, area, and volume and identify whether the application of the concept of perimeter, area, or volume is appropriate for a given situation.</td>
<td>33.33%</td>
<td>3</td>
<td>66.67%</td>
<td>6</td>
<td>0.00%</td>
<td>0</td>
<td>0.00%</td>
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</tr>
<tr>
<td>Course</td>
<td>Percentage</td>
<td>Score</td>
<td>Pass</td>
<td>Fail</td>
<td>Total</td>
<td>Pass Fail</td>
<td>Total</td>
<td>Pass Fail</td>
<td>Total</td>
<td>Pass Fail</td>
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</tr>
<tr>
<td>Computer Technology 3-5.1 – Demonstrate an operational knowledge of various technologies (drones, iPads, computers, etc).</td>
<td>88.89%</td>
<td>8</td>
<td>11.11%</td>
<td>0.00%</td>
<td>0</td>
<td>0.00%</td>
<td>0</td>
<td>0.00%</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Computer Technology 3-5.2 - Identify and use available technologies to complete specific tasks.</td>
<td>100.00%</td>
<td>9</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0</td>
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<td>0</td>
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</tr>
<tr>
<td>Computer Technology 6-8.2 - Identify and use available technologies to complete specific tasks.</td>
<td>100.00%</td>
<td>9</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0</td>
<td>0.00%</td>
<td>0</td>
<td>0.00%</td>
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<td>0.00%</td>
</tr>
<tr>
<td>Computer Science 4.1 – The student will construct sets of step-by-step instructions (algorithms) both independently and collaboratively.</td>
<td>77.78%</td>
<td>7</td>
<td>22.22%</td>
<td>0.00%</td>
<td>0</td>
<td>0.00%</td>
<td>0</td>
<td>0.00%</td>
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<td>0.00%</td>
</tr>
<tr>
<td>Computer Science 4.3 – The student will analyze, correct, and improve (debug) an algorithm that includes sequencing, events, loops and variables.</td>
<td>100.00%</td>
<td>9</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0</td>
<td>0.00%</td>
<td>0</td>
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</tr>
<tr>
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</tr>
</tbody>
</table>
Q11 - What improvements can be made to Lesson 4: Drop Zone Drones?

Apply: bullet 1 - extra "will"  bullet 3 - remove "the" I'm not seeing some of the math that is referenced, but if I actually conducted the program, I would possibly see a decimal out to 3 places. Just can't picture it.

Indoor options would be nice

All of the lessons so far have been wonderful. Me, being a person not very familiar with engineering and coding and STEM... I am having a hard time comprehending how the students will know what to do. How will the students know how to create a design? Is the design that they create literally the design they want their drone to fly in their literal room? Or is the design a coding design of codes needed to make their path possible? So in Lesson 4, the youth were learning how to deliver items...but not dropping them? And this lesson is focused on just dropping?

This lesson is by far my favorite. If you think about it, I would add a place to draw a redesign that goes with “what would you change”, it isn't necessary, but would flow very well with the engineering design process.

Q12 - What did you like about Lesson 4: Drop Zone Drones?

Kids love the egg drop program, and I think dropping even a small toy from 25 feet up would be engaging.

Very practical since companies are using drones and rescue and first responders to deliver supplies packages and equipment

I love the creative name!!

This lesson is very well articulated, thought out, and hands-on.

The background description is more clear in this lesson (bullet point 5)

Q13 - Please rate the following on the effectiveness of the “Drone the Unknown” Lesson 5: Drones in Action to reinforce the following Virginia SOLs.

<table>
<thead>
<tr>
<th>Question</th>
<th>Extremely effective</th>
<th>Very effective</th>
<th>Moderately effective</th>
<th>Slightly effective</th>
<th>Not effective at all</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Computer Technology 3-5.1 – Demonstrate an operational knowledge of various technologies (drones, iPads, computers, etc).</strong></td>
<td>66.67%</td>
<td>22.22%</td>
<td>11.11%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Computer Technology 3-5.2 - Identify and use available technologies to</strong></td>
<td>77.78%</td>
<td>11.11%</td>
<td>11.11%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Q14 - What improvements can be made to Lesson 5: Drones in Action?

Can’t think of anything

Because of the presentation, you could also include English SOLs

You may want to put a time limit on presentations if working with a limited amount of time. Maybe include in the presentations that youth should mention their role throughout the program and what they have learned/what they would suggest improving or would want to learn in the future.

Well done!

Can this be combined with using the drones themselves as well? I wonder about the timing here.

Q15 - What did you like about Lesson 5: Drones in Action?

Including the public speaking activity as part of the program. Our youth need to understand that public speaking ability is critical in a number of careers. Entire curriculum has a natural flow from lesson to lesson.

Great for developing critical thinking skills
I loved that this lesson tied together all the lessons and tied in a real-world connection. Bringing in career professionals that work with drones is awesome. Don't forget about career professionals that work with coding! You could even invite someone from Amazon.

This is a very good complimentary piece to tie in careers with drones, so that it isn't just another "fun activity", but a full scale learning opportunity tied to real world issues and careers.

**Q16 - Please rate the following on the effectiveness of the “Drone the Unknown” curriculum to addressing the following life skills.**

<table>
<thead>
<tr>
<th>Question</th>
<th>Extremely effective</th>
<th>Very effective</th>
<th>Moderately effective</th>
<th>Slightly effective</th>
<th>Not effective at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teamwork</td>
<td>66.67%</td>
<td>33.33%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Self-Responsibility</td>
<td>22.22%</td>
<td>44.44%</td>
<td>33.33%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Critical Thinking</td>
<td>88.89%</td>
<td>11.11%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Problem Solving</td>
<td>100.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Decision Making</td>
<td>66.67%</td>
<td>33.33%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Service Learning</td>
<td>11.11%</td>
<td>11.11%</td>
<td>11.11%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Planning or Organizing</td>
<td>44.44%</td>
<td>55.56%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Wise Use of Resources</td>
<td>22.22%</td>
<td>55.56%</td>
<td>22.22%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Communication</td>
<td>44.44%</td>
<td>55.56%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Cooperation</td>
<td>66.67%</td>
<td>33.33%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Conflict Resolution</td>
<td>33.33%</td>
<td>22.22%</td>
<td>44.44%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Sharing</td>
<td>55.56%</td>
<td>44.44%</td>
<td>0.00%</td>
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</tr>
<tr>
<td>Contribution to a group</td>
<td>88.89%</td>
<td>11.11%</td>
<td>0.00%</td>
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<td>0.00%</td>
</tr>
<tr>
<td>Marketable/useful skills</td>
<td>66.67%</td>
<td>22.22%</td>
<td>11.11%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Personal Safety</td>
<td>11.11%</td>
<td>55.56%</td>
<td>33.33%</td>
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<td>0.00%</td>
</tr>
<tr>
<td>Self Esteem</td>
<td>22.22%</td>
<td>44.44%</td>
<td>22.22%</td>
<td>11.11%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Leadership</td>
<td>33.33%</td>
<td>44.44%</td>
<td>22.22%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
</tbody>
</table>
Q17 - How does the curriculum bring the real-world application to youth? Check all that apply.

- Connection of coding as the basis of all technology
- Introduction to career opportunities
- Usage of drones in real life situations
- Evolution of technology
- Using drones for efficiency
- Using drones for increased safety
- Coding as a marketable skill
- Increased interest in STEM activities

Q18 - What changes do you think would improve this curriculum?

This could be made into a six lesson curriculum.

Funding suggestions

- I would offer more lessons on coding or provide additional information into coding.
- I would add some "cheat sheets" for some of the questions to help those who would not consider themselves an "expert" feel comfortable using the curriculum.
- Perhaps allowing alternate activities to allow youth to fly the drones outside of coding. Is there a way to incorporate flying the drones in all 4 lessons?
Q19 - What things did you like about the curriculum?

It’s awesome! It’ll be a big hit with middle school to junior high age students. Teachers will love it as well as after-school programs.

I love that its simple to use and seems ready to go!!!

I liked that youth got to actually code a drone and fly it, along with delivering objects. It is clear that the youth are gaining skills throughout the program and that is wonderful. I am sure the program is very rewarding!

I love using hands on activities to meet the standards, and making it crosscurricular!

This is such a timely subject. It is hands-on, easy to understand, and matched well with SOLs. Excellent material!

Worksheets for youth are handy and keep everyone on track.