computer science, engineering, and design!

AT COLORADO ACADEMY
At Colorado Academy, we are focused on teaching 21st century skills in a developmentally appropriate way for children of all ages—including critical thinking, communication, collaboration, creativity, cultural competence, and character education. We believe those skills are best learned when they are project-based, and we are committed to encouraging students to use design thinking, engineering, and computer science in their work.

CA’s commitment to STEAM (Science, Technology, Engineering, Art/Design, and Math) is interdisciplinary by nature. At CA, we recognize these fields overlap. With multiple makerspaces, including the Anderson Innovation Lab, and forward-thinking faculty, CA students are prepared to think expansively, face the challenges of the future—and solve them.

Dr. Michael G. Davis
Head of School, Colorado Academy

“Through the experiences and interactions that students have in their engineering and design classes at CA, students cultivate a confidence and a mindset that they can be actively engaged within their communities and empowered to face the world as designers of creative solutions to real-world, human problems.”

Chris Roads
Upper School Engineering and Design
Upper School

Upper School students have boundless opportunities to design, engineer, and use computer science in project-based learning. Want to build a “Tiny House” out of a retired CA school bus, complete with plumbing, electrical power, solar panels, Wifi, carpentry, and interior design? We did that in the Anderson Innovation Lab! (For more on the Innovation Lab, see pages 4-5).

Maybe you want to build a robot that can sail across CA’s pool? Perhaps you want to compete with the best high school students in the country at computer science challenges—or you may want to launch a future career by learning architectural drawing with 3D modeling software. Upper School students are required to take two trimesters of courses that are designated as Computer Science/Engineering & Design. After fulfilling their requirement, many students take additional courses.

Upper School Courses

Computer Science
- App Design and the Internet of Things
- Introduction to Programming with Python
- Introduction to Programming with Swift
- AP Computer Science Principles
- AP Computer Science A
- Advanced Algorithms and Data Structures

Engineering & Design
- Toy Making
- Flight
- Digital Design and Fabrication
- 3D Digital Design and Fabrication
- Innovations Playground: Robotics
- Innovations Playground: Human-Centered Design

Cross-Departmental
- Audio Engineering
- Introduction to Statistics and Data Science
- Business Intelligence, SQL & Data Visualization
- Performance Innovations
- Introduction to Architectural Drawing*
- Digital Fabrication Art*

*These courses do not fulfill the two-trimester requirement for graduation.

“The “A” in STEAM is vital to innovation, because artists are accustomed to not having one answer, and they are tenacious in their approach to solving problems, often using multiple approaches and techniques. They make many “mistakes” which often turn into solutions.”

Katy Hills
Upper School Visual Art
From our Students

“When I took a course in the Innovation Lab, I got hands-on experience working with tools that I had never used before. We learned to record and track every step in our work, which taught us how important it is to have every detail fine-tuned before you start a major project.”

Mari Annest
Class of 2019

Anderson Innovation Lab

Inside Colorado Academy’s Innovation Lab, students are participating in a technological and creative learning revolution, where doing is what matters. Here, trial and failure help teach perseverance and determination, and eventually, success. With access to materials and machines, methodologies and mentors, CA students are learning to invent and inventing to learn.

The Lab is a 1,300-square-foot, two-story workspace with exposed ductwork, nearly floor-to-ceiling windows, and an impressive list of tools and equipment which grows every year.

Equipment

- Epilog Fusion M2 Laser Cutter/Engraver
- ShopBot 4’x8’ CNC mill
- Makergear M2 3D printers (2)
- FormLabs Form 2 Stereolithography Resin 3D printers (2)
- FormLabs Form Wash and Form Cure 3D-print processing systems
- Cubify Sense 3D scanner
- Miller Millermatic 211 MIG welder
- Miller Spectrum 625 X-treme plasma cutter
- Makita LC1230 radial arm saw for metal
- Baldor 1.5Hp grinder and buffer
- Metabo 8.5A angle grinder
- Kerr Electro-Melt metal casting furnace
- Wall 1864 Soldering guns
- Weller WP35 Soldering irons
- SawStop table saw (with auto braking system)
- Jet 14” Deluxe Pro bandsaw
- DeWalt DWS780 compound miter saw
- DeWalt DW34 planer

- DeWalt DW788 scroll saw
- Jet JSG-96 belt and disk sanders
- Festool ETS 150 and 125 orbital sanders
- Festool CMS router table
- Jet JJ-6CSDX jointer
- Jet 17DX drill press
- Milwaukee cordless drills
- Milwaukee cordless jigsaws
- Laguna dust collection system
- Festool CT 26 E HEPA dust extractors
- Sjobergs Elite 2000 workbench
- Woodworking hand tools by Veritas and Lee Valley
- Dremel 4200 kit
- Traditional and digital measuring tools
- Raspberry Pi, Arduino, and Circuit Playground microprocessors
- Class set of Dell Precision laptop computers
- Dell Optiplex Desktop computers (4)
- 52” LCD display

Software & Audio Engineering Software

- SolidWorks
- Vectric Aspire
- CorelDraw
- Rhino
- Autodesk Meshmixer
- PhotoGraV
- Simplify3D
- RealFlight
- LibrePilot
- Adobe Creative Suite

- Pro Tools
- Native Instruments Ultimate bundle
- Universal Audio UAD plug-ins
Recent Student Projects
- RC Quadcopter racing drones
- RC Airplanes
- 3D carved wooden sunglasses frames
- 3D printed textured Rubik’s Cube for a blind puzzle enthusiast
- 3D printed salt and pepper shakers topped with student-designer’s head
- Apple cider press and grinder
- Japanese-style steel and wood custom dog house
- 3D printed Robotic hand controlled by a glove with flex sensors and an Arduino Uno
- Contoured chaise-style lounge chair with living hinge
- Foot fidget device for classroom use
- Car art/toy desk for kids
- Personalized lap desk
- Custom wall clocks
- Dr. Seuss bird house
- PVC marimba
- Marble track game
- Half-moon-shaped rocking chair with henna design-inspired carvings
- Self-pitching batting machine
- Adjustable couch/study desk
- Laminated veneer skateboard deck
- Laser-cut cherry wood wine rack
- Arduino-based DJ controller that works in conjunction with Ableton Live
- Arduino-based Light Harp that uses light sensors to control software synthesizers
- Switch Port writeable light switch surface—launched on Kickstarter.com

“From our Faculty

“The beauty of teaching STEAM (Science, Technology, Engineering, Art/Design, and Math) is that these courses are interdisciplinary by nature—they overlap and don’t fit neatly into silos, and we recognize that. We have to be adaptable, nimble, and open to change, and luckily we have a faculty who appreciate that and are willing to develop courses that help students learn in a developmentally appropriate way.”

Dr. Jon Vogels
Upper School Principal
From our Former Students

“Even at MIT where everyone is so accomplished, I had received more of a Computer Science education at CA than many of the other students had received at their schools. A lot of my fellow students had learned computer science by taking six-week summer courses outside their school. What those students got outside school, I got inside CA.”

Hidai Olivas-Holguin ’17
MIT

Computer Science

At CA, many students are discovering programming and coding because of the two-trimester requirement in Computer Science/Engineering & Design.

“I needed to fulfill the requirement,” says Senior Alena Holbert, “and I accidentally found out I was really interested in computer science.” After Holbert took Introduction to Programming with Python her Freshman year, she never looked back. Four years later, she has flown through CA’s Computer Science curriculum, culminating with an Independent Study “From Nand to Tetris: Building a Modern Computer.”

Kimberly Jans, Upper School Computer Science and Technology Coordinator, has seen the transformation of computer science at CA. During the early years, she might only have one student in AP Computer Science. Now her AP class is at maximum enrollment. “They work hard, and often they fail—and then boom, it works and their faces just glow,” Jans says. “They are learning computational thinking, and those skills are easily applied to other courses and their future careers—whether they become scientists, doctors, teachers, lawyers, or CEOs.”

Computer Science Courses

- App Design and the Internet of Things
- Introduction to Programming with Python
- Introduction to Programming with Swift
- AP Computer Science Principles
- AP Computer Science A
- Advanced Algorithms and Data Structures
Competing in Computer Science

When you hear about a competition, you might not immediately think about programming or coding. But in May 2018, when top Upper School computer science students Eric Bear, Cooper Bedin, Alena Holbert, Alex Kim, and Will Smart competed in the American Computer Science League (ACSL) National All-Star Competition, they came in fifth out of 20 teams, the highest that CA has ever placed in the tournament.

Qualifying for the All-Star Competition doesn’t come without putting in extra time and effort. Once a week after school, students in ACSL meet with Computer Science Department head Kimberly Jans and practice for the upcoming competitions. They cover Boolean Algebra, programming, logic, and other topics that aren’t covered in class.

“Competitions are an awesome way for the students to celebrate their talents,” says Jans. “They help take knowledge outside of the classroom.”

ACSL competitions consist of a written and a programming portion and provide students with sample questions beforehand so they know what to expect. For Bedin, competitions are a place to challenge oneself and to meet people with the same interests. “You learn how to make a solitary passion into a team passion,” he says. “You get to learn a lot of topics you don’t get to learn in class.”

CA students compete in an online Girls Go Cybersecurity contest, HP’s CodeWars, and the Colorado School of Mines Programming Competition. CA has also placed first in the Lockheed Martin CyberQuest Contest.

Each of these events requires students to work as part of a team, helping to buck the stereotype that computer science is an individual activity. “I didn’t really know what I was getting into, but it’s really fun,” Holbert admits. “I like to work through the problems and work as a team.”

With each year that he has been at CA, Bedin has noticed that more students have become interested in computer science. Holbert acknowledges that as the program grows, they are “breaking stereotypes. There’s a lot of diversity in the kids who are interested in it.”

At this year’s All-Star competition, only five points separated the top five teams, showing how competitive CA’s computer science program is at the international level. The CA students who participate in ACSL and other coding competitions may not have a jersey, gear, or a designated field to practice on, but they are a team. They apply themselves in practice and showcase their hard work and what they know at competitions. And oftentimes, they come home with a trophy.

“In Computer Science, we are teaching computational thinking where students break things down, follow a set of steps, and accomplish a goal. When students finally make something work and their program runs, they literally shout, ‘Yes!’ They love it.”

Kimberly Jans
Upper School Science and Technology Coordinator
"My background is in engineering and manufacturing, but I love teaching. I think it’s especially important that Middle School girls can see how much fun design and building is, because that will increase their participation in these fields later in life."

Jennie Kies
Technology Integration and Innovation Specialist

"Teaching STEAM means learning through experimenting. Instead of just accepting technology, students learn how technology and society are progressing together."

Thanh Luong
Middle School Science

CA’s strong emphasis on design thinking at the Middle School level means that every student in every class will do at least one project that involves design thinking—identifying problems, gathering and analyzing information and evidence, getting feedback, making revisions, and making decisions.

Students in Grade 6 focus on a fundamental understanding of circuits, creating a toy with lights. Building on that experience, students in Grade 7 use the Snap programming language and a Hummingbird Arduino to design a robot pet for their clients—Kindergarten students—and Kindergartners then test and critique the finished product.

By Grade 8, students in Middle School have the opportunity to explore the physical world in a science course that blends traditional physics and chemistry with technology and robotics. Students design and launch bottle rockets to study aerodynamics and rocketry.

In their interdisciplinary STEAM elective, Grade 8 students collaborate as artists and engineers using spatial visualization to design appealing and functional solutions to basic and complex problems.

The Middle School Design and Innovation Studio includes 3D printers, a laser cutter, a Computer Numeric Control (CNC) tool for cutting, carving, machining and milling, hand tools, glue guns, littleBits, and recycled materials for students to use in any project.

Students in Middle School are also invited and eligible to compete on CA’s FIRST Lego® League robotics team.
Lower School

By the time students graduate from Lower School, they have been introduced to computational thinking, which emphasizes step-by-step logical planning to reach a successful end result.

Pre-Kindergarten and Kindergarten students start their engineering experience with Legos® in the Lower School iLab. Using Bee-Bots®, programmable robots, they learn beginning coding, sequencing, problem-solving, and, by working in pairs, collaboration. The work in the iLab is reinforced in the Pre-Kindergarten classroom, where a “Mini Innovation Lab” gives students the opportunity to create from their imagination. Students in Grades 1 and 2 continue working in iLab where they ideate, create, innovate, and collaborate. Those skills are reinforced in their homeroom classes during Primary Lab each week.

By Grades 3-5, Lower School students graduate to Ozobots, which can be programmed using a combination of color paths. Grades 4-5 also use Dash and Dot robots to accomplish a series of programming challenges, and students can participate in the international Wonder League Robotics Competition. In their science studies, students learn drag-and-drop programming and building skills using Lego® WeDo robots, while Fifth Graders are introduced to Lego® EV3 robots.

Lower School students enhance their coding skills in Scratch, a coding language for youngsters developed at MIT, by enrolling in an after-school program offered by MindDance. Students also work with Makey Makeys, an invention kit that turns everyday objects into touchpads that activate circuits. All students have experience with 3D design, modeling, and printing by the time they leave Lower School. The 1:1 program—one iPad per student—begins in the Grade 5 and continues through Upper School.

“By the time they are in Grade 5, students have confidence in their ability to choose the right approach to a programming, engineering, or design challenge. It’s thrilling for them, and they don’t want to stop.”

Bill Witt
Lower School Technology Coordinator

“With their inquisitive minds, Pre-K students are at the perfect age to explore and find new ways to create and build.”

Mary Karst
Pre-Kindergarten Director
Special Programs

**REDI Lab**
REDI (Research, Entrepreneurship, Design, and Inquiry) Lab is a 12-week self-directed learning experience for select CA Juniors. Students have the option to pursue projects that involve Computer Science/Engineering & Design.

One REDI Lab student, Junior Ari Fierer, took his interest in woodworking and spent his REDI Lab time using the tools in the Anderson Innovation Lab to build a line of furniture. He started his own business, Fierer Designs, and now has several commissions for additional pieces. “I liked this project because I was able to say, ‘I made this.'” Fierer says. “I created something that’s tangible, that other people can experience. As you’re working, you have to deal with unexpected curves and twists, but at the end, you have a product that you are proud of.”

**Computer Science Festival**
The Computer Science Festival is held during Computer Science Education Week. Students schoolwide participate in “Hour of Code” activities, and both students and parents can sign up for mini-sessions on Scratch, soft circuits, littleBits, Build an App, and many more.

In addition, there are many open activities for all to try, including Dash and Dot robots, Ozobots, Bee-Bots®, Spheros, Sewable Electronics, Makey Makey®, littleBits, and Bitsbox apps.

**Family STEAM Night**
Colorado Academy’s Family STEAM night offers an evening to experiment with Science, Technology, Engineering, Art/Design, and Math. This event for Lower School students and their parents features an array of programs with hands-on fun and activities. Students and parents can try Dash and Dot robots, origami and mathematics, a simulated mission to Mars, and many other options.

**Robotics/Coding Competitions**
Lower School students have the opportunity to participate in the Wonder League Robotics Competition, which uses Dash, Dot, and Cue robots to solve programming challenges.

Middle School students can opt for the FIRST LEGO® League competition team, which builds and programs a robot to solve a challenge based on a real-world topic of scientific interest. Past challenges have included such topics as climate, nanotechnology, and transportation.

In the Upper School, advanced Computer Science student teams compete nationally in coding challenges. At the American Computer Science League National All-Star Competition in May, students compete based on their scores on challenge problems during the school year. Other competitions during the year in which CA students participate are: Girls Go Cybersecurity contest, HP’s CodeWars, the Colorado School of Mines Programming Competition, and Lockheed Martin’s CyberQuest Contest.