

INFOTECH

Scratch: Computer Programming for 21st Century Learners

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From designing video games to producing animated movies, an increasing number of young people envision themselves in technology-related careers.

Unfortunately, many students have only experienced the user side of new media and may not be aware of the computer programming that goes into the creation of these products.

When microcomputers first became popular, many students learned BASIC, Pascal, or other easy-to-learn programming languages. In the 1980s, schools taught a simple language called Logo to provide a foundation in programming. Children used simple instructions such as FD50 RT90 to move a tiny turtle around the screen.

In his classic text *Mindstorms* (1993), Seymour Papert stressed that programming encourages discovery learning and problem solving. Children are doers and thinkers that construct knowledge based on active engagement in learning experiences.

Today, computer classes often use web development tools, learning interactives, and social media websites allowing few opportunities to apply the problem-solving and deep thinking skills required in a higher-level programming environment. Enter *Scratch*, an educational programming language that allows students to explore a wide range of programming skills.

WHAT IS SCRATCH?

Developed at the MIT Media Lab, Scratch allows learners to experiment by snapping together visual coding blocks to control pictures, sounds, and other elements. Scratch is freely distributed for Windows, Mac OSX, and Linux. The word "scratch" was originally used in musical remixing done by DJs with a turntable in hip-

hop music. In the computer software, scratching refers to reusable pieces of code that can easily be combined, shared, and adapted. Students can create stories, games, art, music, animations, and much more.

The software is designed to be intuitive and easily learned by developers of all ages without programming experience. Users create projects using downloaded software, then upload their projects to the Scratch web site for sharing. For instance, the Women Astronauts project, scratch.mit.edu/projects/eduscapes/907918, celebrates Women's History Month and highlights the book *Almost Astronauts: 13 Women Who Dared to Dream* by Tanya Lee Stone (2009). See Figure 1.

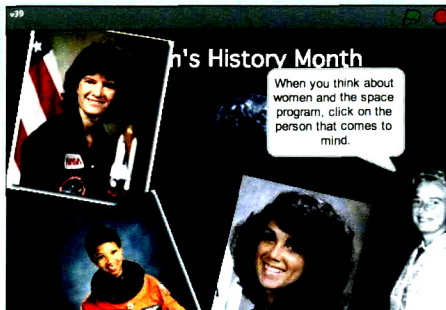


Figure 1. Women Astronauts.

HOW DOES SCRATCH WORK?

After downloading and installing the free software from the Scratch web site, scratch.mit.edu, users drag chunks of code from the blocks palette into the script area. These pieces of code are combined to create actions for objects called sprites. The results can be seen on a stage.

For instance, a student might create a conversation between two characters. See Figure 2 for a dialogue set in the Middle Ages, scratch.mit.edu/projects/eduscapes/900587.



Figure 2. Middle Ages Dialogue.

The Scratch project Wordcloud, scratch.mit.edu/projects/chalkmarrow/660750, works like the popular Wordle.net web site. Projects like this can be used to show young people how they can create projects like they see on the Internet.

HOW IS SCRATCH USED ACROSS THE CURRICULUM?:

Rather than simply being an exercise in programming, Scratch is intended to be a practical tool allowing students to create meaningful personal as well as educational projects. To understand the broad spectrum of applications, it's useful to explore the online community associated with Scratch.

The Scratch Gallery, scratch.mit.edu/galleries, provides access to thousands of projects. The Scratch web site works best with the newer web browsers such as *Safari* and *Chrome*.

The Design Studio, scratch.mit.edu/galleries/browse/clubbed, provides projects that are helpful in learning and creating, while the Featured Section, scratch.mit.edu/galleries/browse/feature, highlights projects identified by the Scratch developers as particularly interesting.

Art

Users of Callig, scratch.mit.edu/projects/chalkmarrow/23058, learn Chinese calligraphy. In Escher, scratch.mit.edu/projects/goch/285091, explore how the paint tools can be used to make drawings like the artist M.C. Escher. See Figure 3.

Language Arts

Scratch is an excellent tool for writing short, animated stories like The Pizza Dude, scratch.mit.edu/projects/xX-MikeyPXX/721500, or Haiku <scratch.mit.edu/projects/chalkmarrow/239106>. Some young people enjoy creating characters. Consider creating your own clan stories. Use the Gemclan, scratch.mit.edu/galleries/view/29691, to get started.

Some projects are designed for older students. For instance, the Photo Journalism project, scratch.mit.edu/projects/journeegk/207385, provides an interactive look at the history, techniques, and ethics related to photos in journalism.

Math

Use math simulations such as Lemonade Stand, scratch.mit.edu/projects/howard-abrams/333016, or games like *Dino Odd*

and *Even*, scratch.mit.edu/projects/howard-abrams/333016. Involve students in using Scratch to share their understanding of math concepts such as Geometry in Nature, scratch.mit.edu/projects/icam-peao/852958. Work with teachers to integrate math tools such as Data Workshop, scratch.mit.edu/projects/scmb1/898311, and the Ellipserator, scratch.mit.edu/projects/scmb1/720705, into the curriculum.

Science

From demonstrating Plant Cell Mitosis, scratch.mit.edu/projects/GoldenSpork/190693, to illustrating the Water Cycle, scratch.mit.edu/projects/kkope1/99832, Scratch is a great tool for creating simple animations that illustrate and help explain science concepts. Integrate science lab activities such as the Galileo Thermometer, scratch.mit.edu/projects/chalkmarrow/27574, and Hooke's Law Experiment, scratch.mit.edu/projects/dapontes/860327.

Social Studies

Some teachers are using Scratch to create exciting learning games and tutorials. The Political Qualifications <scratch.mit.edu/projects/dehrha02/84121> project asks stu-

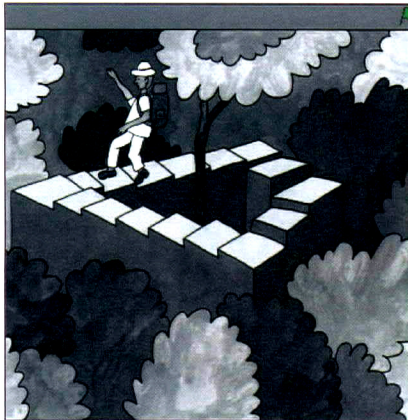


Figure 3. Escher Project.

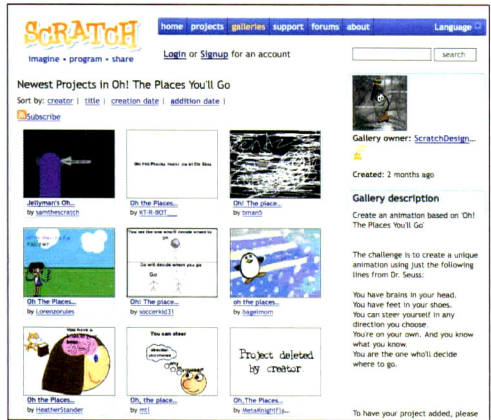


Figure 4. Oh! The Places You'll Go.

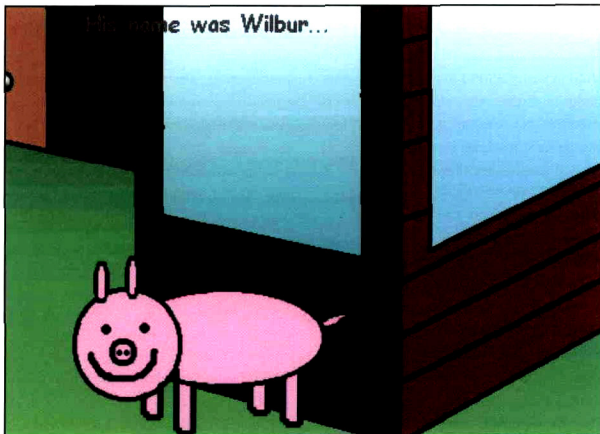


Figure 5. Charlotte's Web.

dents to drag answers into a chart, while the Continents Quiz <scratch.mit.edu/projects/ninja35/328252> asks questions about geography. The Education in Greece <scratch.mit.edu/projects/terminator68/706307> project explores ancient history.

WHAT ARE SCHOOL LIBRARY APPLICATIONS?

Scratch contains many opportunities to address 21st century skills.

Look for collaborative projects that engage children in reading combined with opportunities to develop programming skills. For instance, the project titled "Oh! The Places You'll Go," scratch.mit.edu/galleries/view/101173, encourages participants to create a unique animation based on the Dr. Seuss book. See Figure 4.

The "Your Favorite Book" project, <http://scratch.mit.edu/galleries/view/96365>, asks participants to share their favorite book or create their own story. Story retelling projects such as *Charlotte's Web*, scratch.mit.edu/projects/Masterock/112192, are an easy way to get started with library projects. See Figure 5.

After reading books about fictional creatures, explore the animals created in the Make Your Own Animal project, scratch.mit.edu/galleries/view/89391.

Then use Scratch to invent and share animals such as Ultimate Cat Maker, scratch.mit.edu/projects/Superpika/1021938.

Another approach is to connect to a subject area such as science. Collaborate with a teacher on a project related to the topic of flight. Combine library resources with science content. For instance, ask students to create Scratch projects related to the topic of flight and add their work to the Scratch Design project called Flight!

scratch.mit.edu/galleries/view/98284.

Turn a traditional unit on biographies into an engaging thinking experience. Show students the Scratch projects such as Sousa, scratch.mit.edu/projects/sloebach/772922, Rimsky-Korsakov, scratch.mit.edu/projects/sloebach/863821, Monet, scratch.mit.edu/projects/sloebach/1003429, and Helen Keller, scratch.mit.edu/projects/Stimpson/543876. Then, discuss how they could turn a report into a multimedia project using Scratch.

Look for examples that you can share with teachers. For instance, the Honors Chemistry class at Kirkwood High School, kirkwoodschools.org/faculty/beckerr/hon-chem/, incorporates a Scratch project called the Build-a-Bohr Lab, scratch.mit.edu/projects/beckerr/867623.

In addition to library and classroom projects, consider technology classes and after-school computer clubs for programming activities. Explore the Expo Elementary, scratch.mit.edu/galleries/view/29, and Spring Hill Tech Club, scratch.mit.edu/galleries/view/290, for examples of groups posting projects as part of a club atmosphere. Try club projects such as building a Choose Your Own Adventure, scratch.mit.edu/projects/zachh/199047, game like the one created for Scratch.



Figure 6. Sousa Biography.



WEB SITES

AFRICAN AMERICAN HISTORY

FOR EDUCATORS:

Africans in America—PBS history 1450-1865. <http://www.pbs.org/wgbh/aia/home.html>. PBS presents the journey through slavery from its inception through the end of the Civil War. Divided into four eras, it includes historical narrative, resource bank with annotated images, teacher's guide, and youth activities.

African American Odyssey: A Quest for Full Citizenship. <http://memory.loc.gov/ammem/aaohml/exhibit/aointro.html>. Part of a Library of Congress exhibition, this site contains digitized images of artifacts and narrative to place them in historical context. The Learning Page gives tips on using primary sources in the classroom.

"Been Here So Long" American Slave Narratives. <http://newdeal.feri.org/asn/asn00.htm>. Seventeen first-hand accounts of slave life, selected from the 2,300 slave narratives collected by the Federal Writers' Project. Lesson plans examine how the narratives were collected and address questions of credibility.

Black History Teaching Resources. http://www.smithsonianeducation.org/educators/resource_library/african_american_resources.html. The Smithsonian provides extensive resources on all aspects of African American history. Take a visual tour, delve into the art of William H. Johnson, and view an online exhibition of pioneer aviators. The site also links to the Smithsonian Museum of African American History and Culture.

Dilemmas in Teaching African American History. <http://www.historians.org/perspectives/issues/1998/9811/9811VIE.CFM>. *Catastrophic or survivalist? The lens through which we examine African American history affects how our students understand the past.* This academic essay examines how we teach history.

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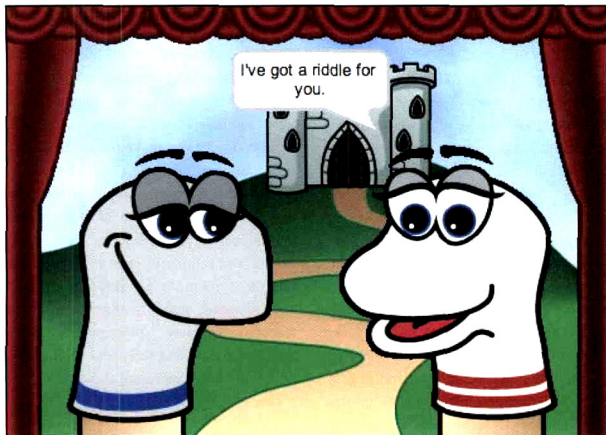


Figure 7. The King Joke.

HOW DO I GET STARTED?

Begin by working with the technology coordinator in your building or a teacher who enjoys integrating computer activities into the classroom.

Dialogue Projects

Creating characters and writing basic dialogue is easy in Scratch. The King Joke, scratch.mit.edu/projects/howardabrams/593354, project is an easy one to remix. Ask students to download the project and add their own joke or riddle. See Figure 7.

Drag and Drop Projects

Scratch provides easy tools for "drag and drop." Use the Drag and Drop Tutorial, scratch.mit.edu/projects/deh-rha02/50014, to learn about the coding. Then, create your own such as the Vegetables Drag and Drop, scratch.mit.edu/projects/eduscapes/900610.

Analyze and Adapt Projects

Involve students in analyzing projects such as the Rubber Band Experiment, scratch.mit.edu/projects/wiggy/143507. Then, ask them to adapt the programming approach to their own project.

The Scratch project web site contains lots of free resources and handouts, info.scratch.mit.edu/Support. You can also find step-by-step directions and project ideas at eduscapes.com/sessions/scratch/create.htm.

WHAT OTHER EDUCATIONAL PROGRAMMING TOOLS ARE AVAILABLE?

Although Scratch is currently the most popular choice, there are other tools that provide students with programming experience.

Etoys

www.squeakland.org, is another tool that allows children to create simple, yet powerful computer programs. Scratch and Etoys are both powered by a free programming language called Squeak, www.squeak.org.

Alice

www.alice.org, is a free tool for creating computer animations using 3D models. Developed at The University of Virginia and Carnegie Mellon, the programming language allows users to create social interactions among characters they create.

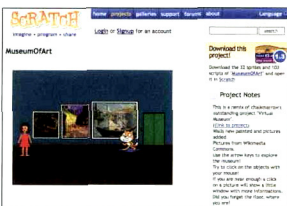


Figure 8. Museum of Art.

HyperStudio

hyperstudio.com, is a popular commercial software package that provides access to a wide range of multimedia tools and allows developers to embed online media such as Google Earth and YouTube. In addition, the built-in authoring language provides students the opportunity for rich programming experiences.

For young people wanting to reach beyond the computer, consider a project using Lego Mindstorms, mindstorms.lego.com. Programmable Lego bricks and components are used to construct robots. Students create programs to control their robots. The NXT kits can be used to create a variety of robot toys including cars, bugs, and other robotic creatures. Developed by MIT Media Lab, command box programming is used to send messages to the robot. An active online community supports educational users. The FIRST LEGO League, usfirst.org, is a club environment popular in schools.

WHY SHOULD SCHOOL LIBRARIANS ENCOURAGE PROGRAMMING?

In addition to being a fun tool for creating computer programs, Scratch is also a powerful teaching tool. Numerous studies have been conducted with the Scratch software to ensure that it is intuitive for beginners. This ease-of-use allows young people to focus on language development, creativity, logic, reasoning, and problem-solving rather than learning the tool itself.

By controlling computer actions, students develop an understanding of how digital media works. Demystifying technology helps young people become more effective 21st century citizens by helping them

understand that people ultimately control technology. In the article "Alice, Greenfoot, and Scratch" (2010, p. 17:5), "engaging and empowering the users" was identified as the most important theme of educational programming languages for students. Young people learn to write programs based on their interests such as stories, games, and simulations and begin to see the power that comes from hands-on problem-solving.

In addition to the benefits of programming, educators can also address other 21st century skills. For instance, the Scratch online community focuses on the theme "Imagine, Program, Share." This emphasis on creating and sharing is central to helping young people understand the positive role that social technology can play in learning. Students can upload their projects to the online community where others can comment, tag, favorite, and even download and remix them into new projects. This global community contains over 1.5 million projects from around the world and allows students to interact with over a half-million other developers.

As a social community, the Scratch web site is closely monitored making it an excellent environment for teaching social technology skills. Individuals are encouraged to flag projects they find objectionable, and inappropriate activity is not tolerated.

Remixing is a unique aspect of the Scratch community and an important 21st century skill. Participants are encouraged to download the work of peers and create their own derivative work. When the new version is uploaded, the original author is also given credit, and the project is shown as a remix of the original. This approach encourages sharing and also models the practice of giving credit for the work of others. In the article "Empowering Kids to Create and Share Programmable Media," Monroy-Hernandez and Resnick refer to this practice of remixing as "creative appropriation" and stress that it is a common and important practice among programmers.

Many people create projects that are great starters for remixes. For instance, the Museum of Art <scratch.mit.edu/projects/goch/577692, project could be adapted for other kinds of museum projects.

A recent study by Hill, Monroy-Hernandez, and Olson (2010) explored the ways Scratch users engage in remixing projects. They found some students don't have an understanding of the difference between plagiarism and cumulative remixing. Young people need to learn these skills in a positive, supportive social atmosphere that focuses on a culture of sharing and mutual respect for work.

Our 21st century learners need opportunities to develop skills in creating, sharing, and remixing digital content. Although teaching computer programming may seem like a daunting task, educational programming languages such as Scratch make it easy and exciting.

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Adapted from a presentation by Annette Lamb titled "Scratch: A New Approach to Programming for Young People," edscapes.com/sessions/scratch.

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