Fostering Creativity and Innovation through Technology

Engage elementary students' artistic minds and teach STEM subjects at the same time with a digital design program.

By Sheena Vaidyanathan

(Above) Fifth and sixth grade students from Los Altos School District in California, USA, created games such as this one using Scratch, a programming language that allows students to create interactive stories, animations, games, music, and art. Play this game by Erin Wong at http://scratch.mit.edu/projects/trackb11s3/1832112.

(Left and above) Fifth and sixth graders from Los Altos created these images of interior and exterior spaces using SketchUp, a program that allows students to make, modify, and share 3D models. Images courtesy of Conner Akiyama, Laura DeMassa, and Emily MacInnis.

Butterfly image courtesy of Jessica S.

To compete in the global workforce, we know that our students must be well educated in science, engineering, technology, and mathematics (STEM) subjects. But, as outlined in the NETS, they must also develop the key skills of creativity and innovation. How can we teach the typically left-brained STEM subjects along with the more right-brained skill of creativity? Is it even possible to teach this seemingly magical concept called *innovation*?

My experience teaching nearly 1,500 elementary school students in public schools has shown me that one possible answer lies in teaching digital art or digital design (vector graphics, 3D design, and computer programming). During the past two years, the Los Altos School District (LASD) in California, USA, has provided each fourth through sixth grader in its seven elementary schools a 12-week digital design program that focuses on using computers for creativity. Digital design is neither learning *about* technology nor learning *with* technology, but learning creativity and innovation *through* technology.

If you walked into one of these classes, you might find a fourth grader editing bitmap images using Seashore or setting RGB values in an open source vector graphic program called Inkscape. This fourth grader will tell you why RGB 255, 0, 0 is red and how she would have to change the alpha value to create a transparent object for a symmetrical pattern. A fifth grader might be designing a model of a futuristic room with multiple levels and underground tunnels using the 3D modeling tool Google SketchUp. A sixth grader might be working on adding an enemy to a video game designed in Scratch, a programming language designed by the Lifelong Kindergarten group at the Massachusetts Institute of Technology.

Many of these concepts may seem a little too advanced for elementary school, but these kids are soaking it in. They are challenged but definitely thriving in the world of digital art. They are also getting an opportunity to express their creativity and understand the STEM material in a real-world setting.

Experimentation Leads to Creativity and Innovation

Art inspires creativity, and in today's world, the computer is the tool for design and creativity. Digital art is particularly well suited for trying out new ideas, and this easy experimentation allows the freedom to create and innovate.

In my digital art classes, I have seen children visibly relax once they find that the undo button works as expected. They are no longer worried about making mistakes, because they can always correct them or just start over again. Unlike in a traditional art class, there is no cost of adding the wrong paint or making a line that cannot be erased.

Sample Lessons from Our Digital Design Curriculum

Imaginary Creatures Using Inkscape

Art concepts: using lines to create shapes, eyes, and other details

Technology concepts: editing paths, grouping objects, exporting files

Math concepts: editing a line by modifying points or nodes

Creating Symmetrical Patterns Using Inkscape

Art concepts: creation of designs using symmetry

Technology concepts: creating clones of objects and changing values per row or column

Math concepts: symmetry, translation of geometric shapes, rows, columns, percentage change values

Designing the Interior of a Room Using Google SketchUp

Art concepts: using rectangles and arcs to create furniture and room elements; using colors and materials

Technology concepts: using push/pull, arc, and offset tools; moving and copying objects

Math concepts: Using *x, y, z* axes to create 3D space; 3D geometry

Creating Art with Programming Using Scratch

Art concepts: geometric and symmetrical art work

Technology concepts: programming concepts of statements, loops

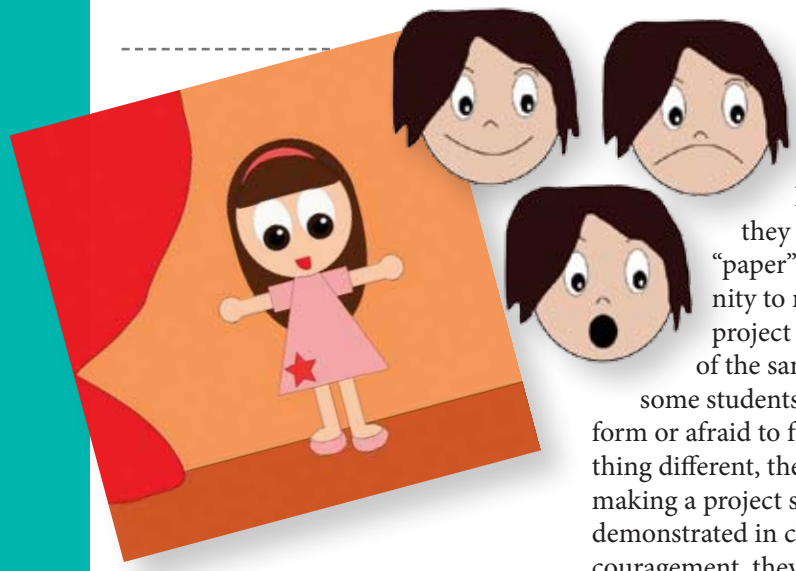
Math concepts: angles, changing geometric shapes with changing angles and number of sides

Video Games Using Scratch

Art concepts: creation of characters and backgrounds

Technology concepts: programming concepts of conditionals, loops, messaging, and variables

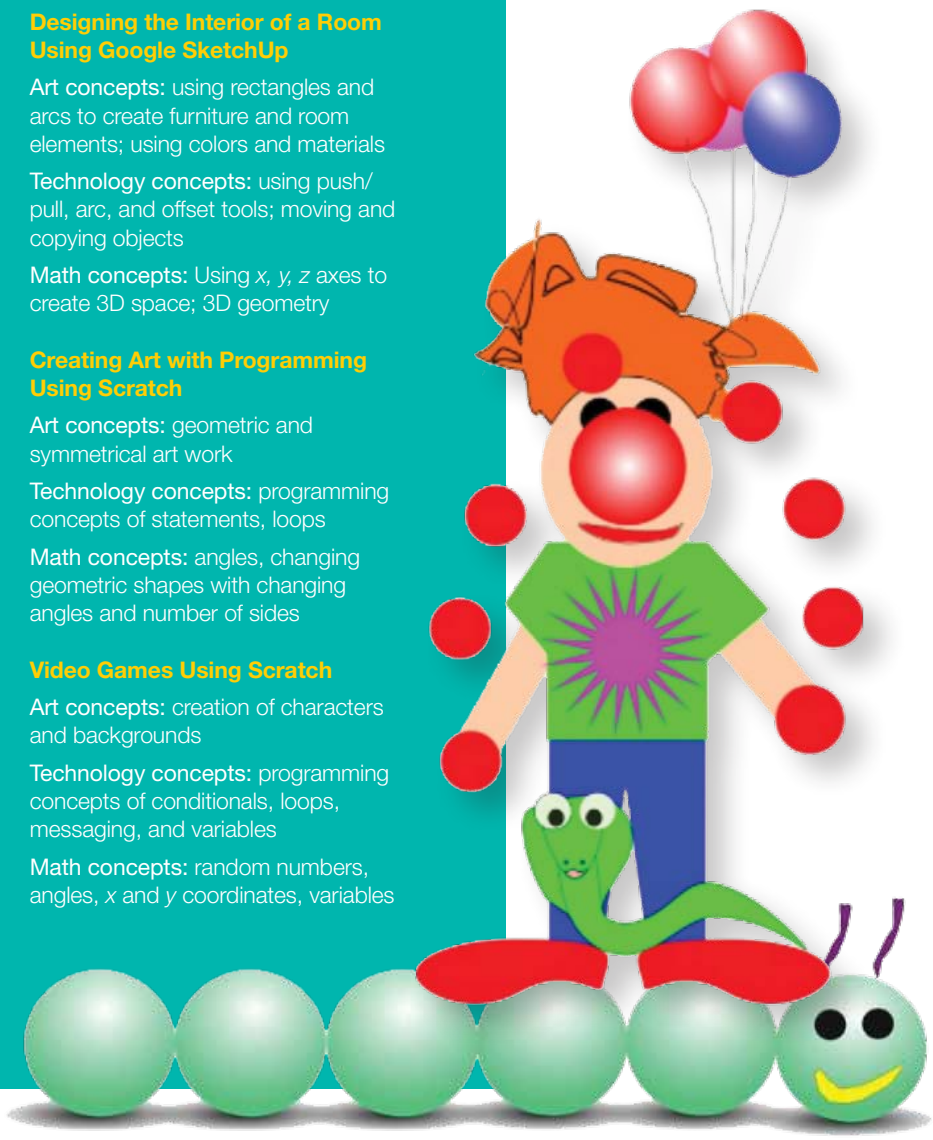
Math concepts: random numbers, angles, *x* and *y* coordinates, variables



Fourth graders in LASD use Inkscape, a vector graphics tool, to create original graphic images. Images courtesy of James Robertson and Aishwarya Panwar.

The students love the idea that they have unlimited "paper" and the opportunity to make not just one project but many versions of the same project. Because some students are eager to conform or afraid to fail if they try something different, they start tentatively making a project similar to the one demonstrated in class. With some encouragement, they make another version, and they try to push the limits and make something a little different. While everyone starts to make a bear that looks like the one I make in the demonstration, they quickly shout out their own unique interpretation: "Mine is going to be rainbow colors," "Mine will wear a top hat," or "Mine is a Cyclops." Like every famous artist, they are experimenting and trying new ways of representing the same subject so that they can express their uniqueness. Even under more controlled situations, such as the video game project where their programming skills are limited, students find ways to be different. They can show their creativity in the story idea, the choice of characters, and the game rules, and they can change these during each class and experiment to make the game their own. The students know this is ultimately an art class and that they can relax and try anything.

Many of my students love to copy a completed project and modify it. Without any encouragement, my fourth grade students create a clone or a "twin" of their character illustration and then tweak its parameters. My fifth grade students turn their finished 3D model of a house into a neighborhood with buildings of similar yet different styles. These students are using



Fifth and sixth grade students created these images using Inkscape while learning about fractals and three-dimensional shapes. Images courtesy of Jean-Luc Quere and Jack Lilygren.

each copy of their work as a sample in a scientific experiment, testing results based on different parameters. This freedom to see the "what if" without fear of failure encourages experimentation and leads to innovation.

Digital Design Reinforces STEM

Digital design is a blend of art and technology. It is built on a foundation of mathematics, science, and engineering. For example, vector graphics is the manipulation of lines and shapes that are defined by mathematical equations. A student editing nodes in a line in Inkscape is experiencing in a very tangible sense the abstract concept that lines change as points are moved, or that a graph gets smoother as they delete points.

"We did that in math!" is something I often hear when my digital design students use angles and polygons to create graphics or use random numbers and variables in a computer programming project. Creating artwork using vector graphics, making a geometric pattern by computer programming, and designing a building in a 3D coordinate system are intuitive ways to learn the STEM subjects.

Digital Design on a Limited Budget

At a time of historic budget cuts, how is this program possible in a public school district? First, all software used in our program is free—open source whenever possible and freeware (free versions or starter versions of software that is not open source) otherwise. Because the software is free, students install it at home and can continue to work beyond the classroom.

Second, curriculum development comes at no cost to the school and is now available under a Creative Commons attribution license. Last, our parents pay for teaching costs by generous donations to the Los Altos Educational Foundation. Most schools already have invested in computer lab setups, including both hardware and maintenance. This program leverages this existing infrastructure. It gives schools a way of using the computers they already have for more than just delivering class content.

Reactions from Students and Parents

As hundreds of surveys, online comments, and handwritten notes attest, students love the digital design class. The enthusiasm in class is palpable. The students rush in excited, and it often takes time to get some of them to leave. The excitement continues after class. Some even come in during recess or lunch, during the school computer lab's open hours. As many have access to the free software on their home computers, they often use it at home. A fifth grade girl told me that she and her friends downloaded Scratch during a sleepover and spent the evening making a video game based on the one she had done in class. She excitedly waved her flash drive when she came into class, saying, "Can I show you what we made?" Not a typical girls' sleepover!

It has been interesting to see how many students use the word *creative* or *creating* when they comment about using Inkscape to make graphics. Here is just one that echoes the feelings of many:

> I like making different, cool things on it. It's like being a scientist in a lab, creating creatures and characters. —*Shannon*

Parents are amazed at what their children teach them at home and are happy to see them designing and creating on weekends instead of just playing video games. Here is a comment from one happy parent:

> Thank you for giving our kids the opportunity to explore the world of digital art. My son, Ryan, is very excited about the class and has already asked me if I could load the program you are using on our computer. It's great to have him come home raving about what is going on at school!
>
> —*Andrea*

Looking Ahead

At a time when many are expressing concern about the lack of AP Computer Science classes in our high schools or the need to encourage middle school girls in STEM subjects, it is easy to ignore technology curriculum in elementary schools. However, to ensure that our students opt for those high school AP science courses or choose STEM majors in college, we must catch them young and get them excited about technology in elementary school. We must challenge these students with real technology classes and not just teach drag-and-drop, template-driven presentation tools. A digital design program in elementary school shows students that learning technology is both relevant and exciting. It inspires and sets the stage for future exploration of technology. A digital design program shows kids what is out there and gets them asking for more. Most important, it gives them a safe place to experiment and learn to create and innovate.

Resources

Computers for Creativity: www.computersforcreativity.com
Digital Art for All: www.digitalartforall.com
Google SketchUp: http://sketchup.google.com
Inkscape: www.inkscape.org
Samples of student work: www.digitalartforall.com/lasd/digital-gallery
Scratch: http://scratch.mit.edu
Seashore: http://seashore.sourceforge.net

Sheena Vaidyanathan has taught visual arts and digital art in the Los Altos School District in California, USA, for five years. Prior to her teaching career, she worked as a computer scientist and technology executive.