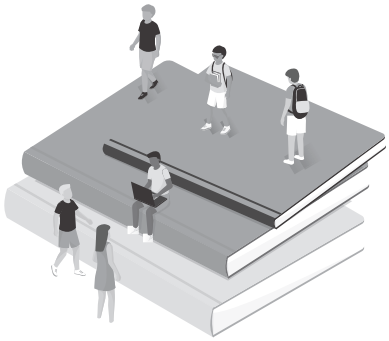

CHAPTER 5

Leveraging Technology for Visual Learning

LEARNING PREFERENCES DESCRIBE one way to organize thinking about digital experiences. Individuals often have a sensory preference for how they access new information, but in truth, we all learn through all our senses. The VARK (visual, aural, read/write, and kinesthetic) learning preferences model (vark-learn.com, 2013) has been in existence since the 1980s.

Visual learners prefer to work with images, such as pictures, charts, maps, drawings, and graphs. Studies indicate that about two-thirds of adults show visual preferences for learning. Elementary classrooms tend to have more visual stimuli than secondary classrooms, but a quick scan of an elementary classroom will show that the visuals are often colorful borders or backgrounds on bulletin boards or posters. The text that predominates on classroom walls appeals more to read/write learners than to visual learners.

In contrast, aural learners prefer to listen to instruction or other students and to discuss what they have learned. Kinesthetic learners like to use all their senses, preferring hands-on experiences and learning from real-life case studies. Students who are read/write learners do best when reading and writing visual text. For more information on VARK learning preferences, see the **VARK** site (vark-learn.com/introduction-to-vark).

For the purposes of this book, activities for read/write preference have been dispersed throughout this chapter on visual learning (reading and creating with graphics) and chapter 6 on aural learning (reading and writing text). Chapter 7 discusses the kinesthetic learning preference.

Most students will not show a strong preference for any one type of sensory experience. Still, teachers should aim to provide experiences across the sensory spectrum to include all students in the learning process. I, for instance, have poor visual memory and struggle to learn through visual media such as videos or pictures. Reading teachers who insist that readers must visualize what they are reading frustrate people like me who simply cannot make pictures in our heads.

Being required to create visual models has strengthened my visual sense-making. I wouldn't want every new idea to be presented to me visually, but I appreciate that visual materials sometimes capture ideas better than words can.

Drawings

When technology is defined simply as the use of any tool, the act of drawing with a pencil or crayons is probably children's introduction to creating visuals with tools. Early-childhood teachers encourage students to draw to communicate ideas, and children draw pictures to plan what they will write as they learn to compose.

Like reading and spelling, drawing skills progress through predictable stages. A chart titled "Drawing Development in Children" by Viktor Lowenfeld and Betty Edwards, adapted from teacher inservice materials by Susan Donley (1987), outlines the stages of drawing skills well (learningdesign.com/Portfolio/DrawDev/kiddrawing.html). The goal is not to identify students in particular stages, but to understand that students progress through predictable stages at differing rates. Thus, their work should be compared only to previous work they have done. Portfolios of drawings throughout the year can illustrate each student's growth in visual representation. Certainly, secondary art teachers value visual portfolios!

Drawing is one way to assess what students are thinking or understanding. Asking students in any grade level to draw processes or create visual models helps teachers informally assess individuals' perceptions of content. Also, when students use original drawings or photos in their projects instead of clip art or pictures taken from the internet, they do not face copyright issues.

Drawing used to be the way I introduced kindergarteners to computers. However, with the proliferation of internet-only devices in schools, such as Chromebooks, students often have few opportunities to draw digitally unless a teacher uses an online drawing tool. For teachers whose students use iPad drawing apps or full-fledged computers, drawing is still a possibility.

Options for Drawing Applications

Online drawing applications enable teachers to continue to engage students in drawing digitally no matter what devices they have. I've listed only a few of the online sites I found; if none of these suits your students, you can find others through a simple search. Except for Pixilart, all the sites are appropriate for all grade levels. Generally the online sites will accommodate all levels of drawing expertise as well.

Online Drawing

Sketchpad (sketch.io/sketchpad) has basic tools and some advanced capabilities such as layers. Pictures can be exported in multiple formats. Sketchpad can be integrated into Google Classroom as well. Tutorials on the site explain the tools and processes for using and integrating Sketchpad.

Canvastic (canvastic.net/net.html) is a simple drawing tool free to use online. Versions for iPads and downloadable software must be purchased.

Drawisland (drawisland.com) is designed for online, iPad, or iPhone and requires no sign-in. The drawing space has intuitive art tools and can be layered and saved. Artwork is visible only to the artist and will still be available when the user returns to the site.

Kleki (kleki.com), like Drawisland, requires no login and saves the drawings in the local driver or on the computer. Standard drawing tools are available, and accessing the help screen brings up information about tools and videos.

Pixilart (pixilart.com) was designed for young artists to support the fundamental skills of designing digital art, games, and programming. Students must register, so this site is not appropriate for under age 13, unless parents give permission. The site is a social platform, so once drawings are published, others can comment. The site also supports areas where special interest groups can share their art. The art gallery on this site shows a wide spectrum of skill levels.

SketchUp (sketchup.com/education/sketchup-for-schools) is 3D modeling software. Schools signed up with G Suite for Education have free access to a browser-based version integrated with G Suite. Free curriculum tutorials are available by grade levels (K–5, 6–8, and 9–12). Additional educational materials are available at **3DVinci** (3dvinci.net). Project Spectrum uses SketchUp to help children with autism spectrum disorder express themselves and connect with one another (builtr.io/designing-a-better-world-for-all-the-project-spectrum-series).

Downloadable Art Software

In classrooms where students can work on computers with hard drives, a few downloadable software programs are worth considering.

Tux Paint (tuxpaint.org) has been freely available for young children for more than a decade. It continues to be upgraded regularly by volunteers and can be used on any platform (PC, Mac, and Linux), including older machines and both iPad and Android handhelds. The tools are robust and the program has been translated, at least in part, into 130 languages.

Krita (krita.org/en) is a free painting tool designed for professional artists and available for PC, Mac, and Linux. This is sophisticated software for serious artists.

Inkscape (inkscape.org/en) is a free professional vector graphics software similar to very expensive programs such as Adobe Illustrator or CorelDraw. The program

will load on PCs, Macs, and Linux systems. This program would be appropriate for secondary students and school art departments.

Project Ideas for Drawing

Allow the following projects to serve as springboards for your own ideas. Think about how these ideas for drawing might be adapted to fit your curricular objectives or grade level.

Self-Portraits

Open the year and introduce the drawing program for young students with self-portraits. These pictures can be saved as part of a digital portfolio or emailed to parents. If the self-portrait project is repeated near the end of the year, parents will have direct evidence of their children's growth in self-awareness and drawing skills. Although a simple activity, the act of creating a self-portrait sits high in Bloom's taxonomy because it requires students to think abstractly about their bodies, which they see only in reflections, and to create a representation.

Favorites

The possibilities of favorites extend into students' personal lives as well as their classroom recall of content. For instance, personal favorites may be holidays, foods, sports, hobbies, summer activities, animals, or books. Students could also draw favorite academic choices: book characters, science topics, historic figures, scenes from a read-aloud, or activities at school. Such drawings, accompanied by captions, show the variety of personalities in a classroom.

Labeled Drawings

Have students generate pictures of content concepts, such as the body of an insect, model of a chemical reaction, or cross-section of an eye. Ask them to label the parts, either from a word bank or with best-guess spelling. This is a much better assessment of understanding than a worksheet with blank lines for writing labels. On predesigned worksheets, students need to recall information only when they label parts, processes, or events. As a result, teachers can only tell if responses are right or wrong and do not know what students were thinking when they chose the labels. However, when students draw their own representations and label them, the drawings reveal the depth of their knowledge as well as misconceptions they may have. This task is appropriate for all grade levels because secondary students study

systems, vocabulary, and other assessable concepts that can be drawn. Asking students to draw their representations of things, processes, or events raises the activity's thinking level on Bloom's taxonomy from remembering to applying.

Illustrations

Drawings can illustrate other projects. When students create illustrations, they can insert the pictures into ongoing projects, such as desktop publishing, slideshows, or online projects. Students have used self-created pictures as re-creations of what they've seen under a microscope for science reports; illustrations for stories, books, and reports; clues for riddles; and replacements for words in rebuses. Because students own the rights to their original works, they can publish the illustrations online or in printed materials.

Math Animals

Explore the **How to Draw Funny Cartoons** (how-to-draw-funny-cartoons.com/draw-animals.html) website section for intermediate students on drawing animals. The animals are basically made with rectangles, triangles, and circles. The website offers tutorials for each animal. To make sure young students understand how the tutorials work, lead them through a tutorial on drawing one of the animals. Then encourage them to try one on their own. They should keep count of the numbers of each shape they use. Then they can create riddle cards. The outside flap would say something like: "What do you have when you add 1 rectangle, 1 square, 5 triangles, and 2 circles? Not just 9 shapes but ..." inside, "... a penguin!" The "How to draw" tutorials could be used for multiple projects across grade levels. Some tutorials are quite advanced and may interest art students.

Timed Sequences

Similar to the previous project, elementary students can use visuals to demonstrate their understandings of a sequence of events. If students are also asked to include labels in their drawings, teachers can assess what they know and what may need to be retaught. This process would work for steps of an experiment, the water cycle, a model of how to do a math problem, the seasons, migration patterns, or a crosscut of the eruption of a volcano.

If the cycle or process is sequential and each step has a different drawing, then students can work independently. An example would be the water cycle. Students could draw the phases of the water cycle with one phase per slide in presentation

software and complete the work independently. The slides could then be set to advance in a timed sequence of 3 seconds to show how the water cycle works.

If, however, the sequence builds by adding on to an original slide, such as with the life cycle of a plant where the sequence of events happens in the same place but each event is distinct, students may not be able to work independently. The teacher may need to guide students through each step.

For instance, the life cycle of a butterfly can be depicted as happening in one specific tree, but the stages of the butterfly's life are distinctly different. To illustrate the life cycle of a butterfly, have students follow these guidelines:

1. Create a master picture with trees and other landscape features. Label the features. Save the master picture.
2. Open the master picture and save a copy as "eggs." Draw butterflies and butterfly eggs on tree leaves. Label the new features. Save.
3. Open the master picture again and save a copy as "caterpillars." Draw caterpillars on leaves to show them munching. Label the picture. Save.
4. Open the master picture and save a copy as "chrysalises." Draw the chrysalises hanging from branches. Add labels. Save.
5. Open the master picture and save a copy as "butterflies." Draw the butterflies hatched from the chrysalises. Add labels. Save.
6. Import the series of pictures into a slideshow. Use the auto timer to advance the slides every 2–3 seconds. The resultant slideshow demonstrates the life cycle of a butterfly.

Some sequences build on one another and might be considered cumulative. An example would be the life cycle of a plant. As with the life cycle of the butterfly, the background picture for a plant stays the same, but each stage of the plant's life adds additional details onto a master picture. Each stage (seeds, roots, stems, etc.) simply advances the process cumulatively. Other events are cumulative as well, such as the mathematical model of exponential growth or the scientific model of heredity through generations of a family tree.

Visual Representations

Combining words and pictures increases students' retention of concepts. For instance, when students are learning vocabulary, retention rates increase when they

not only use definitions but also have pictures that illustrate the words. Students can create vocabulary books with each word defined, illustrated, and used in a sentence that relates to the picture. Visual representations can also be powerful for conveying content vocabulary in math, science, and social studies. Words such as *archipelago* or *convex* can be understood and remembered most effectively when they are accompanied by drawings that make the concepts visible.

Figurative aspects of language, such as similes, metaphors, and idioms, become more understandable and concrete when students create drawings to illustrate comparisons embedded in the language. One classroom of English language learners created a dictionary of idioms with an illustrated page for each idiom.

Photography

Because digital cameras are now embedded into many computers and cell phones, picture-taking has become a common activity in families. The technology of digital cameras has evolved so that even preschoolers can take usable photos. Yet, I find teachers often overlook the potential for photographs as tools for students to use to demonstrate their thinking and knowledge.

When elementary students use digital cameras, their photos often differ dramatically from pictures taken by teachers and parents. Teens and adults tend to snap pictures of students in settings where they are learning; young students take pictures of what they are learning. Perhaps pictures also tell you about values: teens value their peers; teachers value students; and students value the new information and experiences in the present moment.

If students have iPads or cell phones, assignments requiring photography are easier than when students are using Chromebooks or laptops. Some Chromebooks and laptops have cameras, but the cameras are often front-facing only. To take a picture, students have to angle the screens and contort their bodies to see how the pictures will look. Resultant photos are often unsatisfactory. Depending on your context, you may want to supplement your classroom with digital still cameras. These can often be found collecting dust in school closets or can be solicited from families who have abandoned their digital cameras for cellphone picture-taking. Do not assume all students will have access to a phone; in my research on fourth through sixth graders, fully 50% of students did not have access to any devices at home.

The cost of printing pictures, particularly in color, remains significant. Now that pictures are digital, teachers have options for using photos without printing them.

Students can upload the pictures and projects to websites or email them to parents. However, a critical issue remains: picture file size.

VOICES OF EXPERIENCE

Boni Hamilton, Ed.D,. PhD
Centennial, Colorado

I bought a camera designed for elementary kids because it was digital, cheap, and sturdy. I liked the idea of putting cameras into students' hands, but I didn't want to invest much money until I saw whether it would work. I could think of plenty of things that could go wrong. Most kids wouldn't know how to take a good picture with a camera, so their photos might be blurry or off-center. There was always the chance that they'd just take shots of their friends or of kids goofing off. At least with a digital, I could erase bad pictures without spending extra money. When my now-adult offspring had used cameras as kids, I wasted a lot of money getting really bad pictures developed.

I handed the camera over to several students in the school's day-care program when they were going to the aquarium. I hadn't realized how challenging the task would be for them. The camera had no flash, so their pictures were dark. Then, too, all the photos had to be taken through glass, which had glare from spotlights. Yet, the students came back excited about their pictures and full of detailed stories about each shot. And they had not broken the camera!

A few weeks later, I convinced fourth-grade teachers to let their students take several inexpensive digital cameras on a field trip. The cameras had no viewing screens. Students had to look through an eyepiece, click, and hope. The next day, the student photographers watched me download their pictures from the cameras. As I paged through the pictures, they nudged one another and talked about each shot. I stopped at one that seemed to be mostly tan with a few semicircles of white. "Oops!" I said. "That looks like a mistake. We can delete it." A student immediately

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cried out, “Don’t delete it. It’s important!” What the student had shot was a close-up of how the pioneers carried china plates in covered wagons. The tan area was a heap of dried corn in a barrel; the white semicircular pieces were the edges of the china.

In all the years classes had taken that field trip, no teacher had ever photographed the barrel of corn. They didn’t think it was important. Teachers photographed students in front of the tepee, students standing next to the covered wagon, students riding on the hay wagon, and students sitting on logs to listen to a storyteller. What students photographed, besides the corn barrel, were the two horses pulling the hay wagon, the stakes of the tepee, the rolled-up side canvas of the covered wagon, and other aspects of the field trip that they found fascinating. The pictures changed the conversations students had about the trip as well; the student photographers’ pictures generated more detailed memories.

When students take pictures of what they deem worthy of photographing, teachers see the events through children’s eyes. That’s worth a lot more than the price of a digital camera!

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Picture File Options

Advancements in technology prevent nearly all problems that were once so common with cameras except picture file size. Those who upload pictures to social media may have learned, through experience, how to size pictures correctly. For those with limited experience, the following summary can help ensure that student projects using pictures do not end up too large for emailing or posting to the web.

Picture Compression and Quality

The primary concern with photo extensions is the compressibility of the photos. Compression decreases the amount of required memory, but it also may affect the sharpness of pictures when they are enlarged. For elementary students, pictures should be compressed to ensure that their projects do not become so big they cannot be emailed or posted online.

Photos can be saved as files with different extensions, and each extension has its own characteristics. The following are the four most common digital image extensions you might encounter when using digital cameras.

bmp: This file extension is a standard in Microsoft Paint. Students should be encouraged to change this extension to .jpg before they save their drawings. Because .bmp files are huge and high quality, they are difficult to compress without losing quality, so they take much more memory than other files.

gif: Popular for websites, .gif files compress without losing quality and can store animations. Their large file sizes make them more suitable for professional web design than classroom projects.

jpg or jpeg: This file extension is favored for internet use and should be the file extension of choice for students. Because .jpg files are compressed (a 10%–20% compression is usually enough), they lose quality, but unless they are highly compressed (60% or more), the change in quality is negligible. The .jpg files are easily interchangeable among operating system platforms, such as Windows, Mac, and Linux. Pictures on Macs should be in .jpg if students want to export them to any other platform.

tif or tiff: This file extension is typically used by professional artists and photographers and for files in commercial programs, such as Adobe Photoshop or Corel Painter, so that they retain high quality. The files are huge, even when compressed, and their level of quality is typically not necessary for student projects. Only the smallest .tif files can be emailed.

Changing File Extensions and Resizing Pictures

Sometimes setting a camera to good, rather than best, quality decreases picture file size as well. Yet, if students are placing a lot of photos in one file, as in a collage or slideshow, the combination of pictures, even when taken at good quality settings and compressed as .jpg files, may still take too much memory for the file to be emailed or posted online. In that case, pictures need to be resized to reduce their memory requirements. Resizing is not the same as dragging the edges of a picture to make it look smaller on a page. Resizing requires using a photo-editing software application to change the image.

Large or high-quality pictures require a lot of memory. Shrinking their appearance by dragging the corners does not make the file size smaller. In a slideshow or digital story with many pictures, the large file size of the project can end up too big to upload or email.

To resize the photo to decrease the file size, you have several options:

- Open the picture in a basic photo editing application, such as Microsoft Office Picture Manager, iPhoto, or PhotoScape. Among the editing tools will be a command to "Resize." Choose the dimension you want for the picture. Often a size in the 3″–5″ range will be sufficient.
- **Web Photo Resizer** (webresizer.com), a free online photo resizer and optimizer, requires no registration. Not only can you resize photos, but you can crop, sharpen, add borders to, and rotate them. You can even change them from color to black and white. Once you open this site, after 60 minutes of inactivity, your session will end, and your pictures will automatically be deleted from the site. This is an easy site for students to navigate.
- **Pic Resize** (picresize.com) resizes and offers special effects tools to enhance photos. This site will also capture, crop, and resize photos from websites, which does not violate copyright law when the images are used for educational purposes. Photos are deleted 20 minutes after previewing the final picture.

Key Skills for Camera Use

Using digital photos is a great way to meet visual learners' needs while giving all students multimodal experiences. Essentially, teachers can replicate any drawing activity with photography. The difference, though, is that students taking photos will likely be out of their seats and consulting with one another, and students typically stay seated in one place for drawing.

Camera Care

If you are using digital cameras with students, you'll want to consider in advance how you will manage the equipment. When digital cameras are in students' hands, accidents will happen. I tend to be more merciful than punitive because I don't want students to be afraid of making mistakes. Of course, it's easier to be merciful when the camera was donated than when its cost came out of your budget.

You can minimize the likelihood of accidents by taking the following precautions:

- If possible, replace wrist straps with neck straps. A student once accidentally dipped a camera into water several times as he panned for gold. Fortunately, the bath did not permanently harm the camera.
- To avoid tussles among students over one camera, design an equitable sharing plan before they begin taking pictures.
- On field trips, keep cameras in a common basket or carrying case during travel.
- Label all cameras and memory cards—memory cards, in particular, can easily be misplaced or mixed up. Identifiers that match cameras to cards help.
- Designate specific physical locations in your classroom or the library for downloading pictures, removing memory cards, recharging cameras, and storing the equipment, so parts are less likely to be lost or knocked over accidentally.

Key Skills for Using Pictures

At the elementary and possibly middle school level, teachers need to consider factors not necessarily important to high school students. Some young children have not taken pictures themselves, may not be familiar with digital cameras even if they have used cell phone cameras, and may not know how to get pictures from the cameras to their devices.

Students should learn technical skills before embarking on picture-taking projects. These crucial skills include downloading, storing, and accessing pictures; manipulating pictures; and using pictures in other applications.

Downloading, Storing and Accessing Pictures

Over time, the practicalities of downloading and storing digital pictures have been simplified. In many schools and districts, technology specialists can teach students how to store photos so that the pictures are accessible from a common file. Ideally, students have access to a common storage folder on a school or district server or, if a school uses G Suite, Google Drive.

Online photo storage is also available. Elementary teachers need to use online photo services that do not require registration if they want students to upload and download at the site. Secondary teachers have many options, such as **Dropbox** (dropbox.com), Google Drive, iCloud, **Photobucket** (photobucket.com), and **Flickr** (flickr.com), provided that access to the sites is allowed through district filtering software.

Note: Before you ask students to use any photo editing or hosting site, be sure to check all the tabs on the site yourself to avoid students accessing any inappropriate photos. Material on these sites changes frequently. In fact, in the preparation of this book, on one occasion a site had a suggestive photo on its main page, and innocuous photos a few days later. Exercise due diligence.

The following free online photo hosting sites are examples that could be explored by teachers; they are not necessarily the best or most educator-friendly. These are new services I explored as possibilities. As with all technology, if these disappear from the internet, other similar services can be found through an online search.

Image Upper.com (imageupper.com) makes registration optional. Batch upload up to 50 pictures at once, and you'll have a gallery page with thumbnails of the pictures. The site offers to optimize images for faster download.

Use (use.com) has an optional registration and unlimited free image hosting without registration. The site also provides a photo editor that allows you to add captions and speech bubbles. On this site, you can set privacy levels, so if the photos are of students, teachers may want to make the page private. An embed code enables placing the gallery on websites.

Using Pictures in Other Applications

Pictures can tie into any curricular unit or special event. The following ideas refer to particular curricular units but can be adapted to fit the circumstances of your school. Keep in mind that printing pictures, particularly color pictures, can strain a budget quickly. One way to reduce costs is to upload students' projects, including projects using photos, to the school's website or a blog or wiki. Another option is to email projects to parents so they can, in turn, forward them to other family members. Students with computers at home can copy projects onto flash drives or CDs to show at home.

Digitizing Pictures and Print Photos

Sometimes students have picture prints at home or illustrations in books that they want to use in projects. Digitizing is easy with any of the following tools:

Digital or phone camera. Students can always take a picture of a picture. During the camera exploration activity, students might try taking pictures of pictures to learn effective techniques, such as squaring the camera to the picture, reducing glare, and/or using a tripod to steady the camera.

Document camera. Any document camera that connects to a computer is capable of taking pictures of items placed under the lens. This system is particularly effective for taking pictures of drawings, print photos, and book illustrations because students can see exactly what the photo will look like before snapping.

Scanner. Multifunction printers often have scanners. Digitizing is more automated when scanners are used, so this may be the easiest system, but schools are less likely to have scanners available for student use.

Developing Themes

Students create slideshows that present specific themes. These may range from colors or numbers to mathematics, vocabulary, or habitat studies. One teacher guided preschool children to develop a theme of emotion. The children generated a list of emotions. Each one then chose an emotion to demonstrate through facial expressions, and the teacher took separate pictures of them. The assembled book of emotions was available for the students to read and proved helpful for them to label their feelings. A kindergarten teacher had her students contribute to books about colors, counting, and collections. Small groups or individuals could also accomplish this project. Depending on the levels of independence teachers grant, as well as the scopes of the initiatives individual students undertake to create themes and take photos, this project can range across all levels of Bloom's taxonomy.

VOICES OF EXPERIENCE

Laura H. Dariola, PhD, Assistant Professor, University of Kentucky
Laura.darolia@uky.edu

Note: Laura's project reminds us that disposable cameras are also technology tools that can transform students' experiences.

Inspired by Wendy Ewald and Alexandra Lightfoot's book *I Wanna Take Me a Picture* (2002), I created a unit for my second graders called "Exploring Identity Through Photography."

When considering how to bring this project to life, I was also driven by the idea of creating a "third space," as Jackie Marsh discusses in *Popular Culture, New Media and Digital Literacy in Early Childhood* (2005). Marsh writes, "She (McCarthey, 2002) suggests that students who are able, when teachers allow, to transform their identities within classroom contexts can create a 'third space' (Gutierrez, Baquedano-Lopez, & Turner, 1997) in which schooled norms and student lived experience can meet and ensure that children have agency and voice" (p. 30). The notion of students' identities outside of school uniting in a meaningful way with their

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in-school identities carried this project forward in my mind. A second focus was to understand others' perspectives.

We began by reading images: "What is the photographer's message?" "What can I learn from this photograph?" This work led to interesting discussions about perspective. Student Sita observed, "If everyone saw stuff in the same ways, it wouldn't be interesting. Perspectives kind of matter."

I distributed disposable black-and-white cameras, assigned five self-portraits, five family pictures, five pictures of culture, one picture of a tree, and, based on a suggestion made during a personal conversation with Vivian Vasquez, one picture of "fair." The cameras went home, and the photographers got busy.

The room buzzed with a wide array of excited reactions when the developed film was distributed. Soon, students began writing poetry about their photos. After a week or so of writing poems in their writer's notebooks, it was time to choose "the one." This would be the photo and poem to be scanned, enlarged, and mounted on stock paper for display at the annual second-grade assembly.

It was evident by both the vibes and the conversations throughout this unit that my students brought their "outside of school" identities into the classroom in meaningful ways. Using cameras made these moments, people, and places accessible, as the images captured indisputable fodder for conversation.

One area of this project that deserved more attention, in hindsight, was the question of what "fair" looks like. Most of the kids took pictures of even amounts of things. For example, "My brother and I have the same amount of cider. That's fair." I breezed through these responses, thinking they were simpler than what I'd sought—though I'm not sure exactly what I was looking for. As a result, this part of the project kind of fizzled. If I were to do it again, I'd think more deeply about how to investigate the idea that if everyone has the same thing, it's fair. This concept could extend to the resources schools in our city have or could be used to explore homelessness. In my haste, I believe an opportunity was lost.

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In secondary classrooms, developing photo essays on themes such as patriotism, justice, liberty, citizenship, or natural selection could push students to higher levels of thinking.

Scrapbooks and Collages

When students create themed picture collections, they may choose to make scrapbooks or collages. This Scholastic.com article discusses using collages as evidence of learning (tiny.cc/bvgawy).

Online sites offer collage/scrapbook possibilities for free. Some require registration and are suitable only for students over the age of 13. This could be a good option for presenting a themed photo study in any content area. Only a select few free collage makers are presented here, although many more are available.

Canva for Education (canva.com/education) integrates with G Suite, so teachers can make the site available for their students to develop posters and other projects.

FotoJet (fotojet.com) does not require registration for its collage maker. Students can choose a basic design and add pictures. Be aware that the more pictures added, particularly if they are large file sizes, the slower the collage maker will run on the digital device.

Fotor (fotor.com) is a free photo editor as well as a collage maker. As with many sites, students can choose language options, so international students can feel at home on the site. Although the terms of service do not prohibit children under age 13, the site does require registration and has advertising, two considerations elementary teachers should take into account.

Kizoa (kizoa.com) has online tools for making collages and movies. It does require registration, and terms of service indicate students between ages 13 and 18 must have parental permission. Although basic membership is free, Kizoa does offer a lifetime membership for a small one-time payment.

Pic Collage (blog.piccollage.com) is available as a free or paid app for either iOS or Android. Designed originally for scrapbookers, it has become a popular tool for teachers. The app has a School mode, or students under age 13 can simply click CREATE and begin without logging in. Teaching ideas are available in the blog.

Capturing Experiences

Teachers plan field trips and invite guest speakers to make learning experiences more personal for students. Capture what students learn by having them photograph the events. They can then select photos to illustrate essays about the experiences. Visuals often spur more details in writing. This activity requires

students to attend to several skills. Photographers make decisions about what is important to capture, and writers reflect on what they remember about the experience so that they can write about it.

Illustrating Procedures

To help students remember classroom- and discipline-specific procedures, ask students to document them through photos and to write captions for each one. Then post the results. School procedures that most kids find boring, such as fire drills, bad weather accommodations, playground safety rules, and courteous lunchroom routines, will suddenly take on more significant meanings. And essential learning procedures, such as the scientific method's steps, problem-solving scaffolds, and computer use steps, will become more deeply embedded into students' long-term memories. Such combinations of pictures and captions make the information more accessible and meaningful to students. These activities, located on Bloom's taxonomy along the range of comprehension levels, will give students practice in thinking sequentially, systematically, and logically. Furthermore, the ability to visualize and recall these procedures will become valuable, lifelong skills. Think about intelligent adults you've observed who are handicapped professionally and personally because they were never taught how to think logically or to solve problems systematically.

Documenting Sequences

Similar to illustrating procedures, photographs can be used to document a sequence of steps students use during a research or science investigation. Students can use the sequence of photos to create documentation panels/posters that lead an audience through the experience. Learning to document sequences prepares students for creating science projects and for careers in science, technology, engineering, and mathematics (STEM), as well as in writing, teaching, inventing, marketing, and the arts. If students are simply documenting steps based on a teacher's plan, this project falls low on Bloom's thinking levels, but when students are asked, either individually or as groups, to come up with the steps in a sequence, their work fits Bloom's third level, applying.

Highlighting Patterns

Recognizing and creating patterns is a crucial early step in mastering mathematics, so this activity is probably most suitable for primary students. Students can photograph patterns they've created or they've found in the environment. In

one class, students were given random collections of buttons and asked to sort and graph them by pattern. Students used shape, color, size, number of thread holes, texture, and other characteristics for sorting. In another classroom, students were asked to create patterns of colored beads for neck chains. Photographing the results and giving each child a chance to write a caption about the pattern provided opportunities to assess students' understandings informally. In these projects, students apply their knowledge of patterns to new situations.

Reenactments

After students have read a book or studied an historic event, they can photograph themselves reenacting the experiences or draw a series of pictures to retell the events. The process of retelling through reenactment embeds learning into long-term memory. Reenactments emphasize evaluation and analysis skills because students need to figure out how to communicate main ideas. Do not limit this to elementary students—teens take delight in acting out scenes and documenting them. Such a project could be easily adapted for video production as well.

Composing with Visuals

Using visuals to spark or complement writing is valuable at all grade levels. The field-trip pictures, for instance, may trigger an idea for comparing life today with how people lived in another era or can become the basis for a persuasive essay on why a particular field trip should or should not be repeated the following year. Students can also write first and then draw or take photos to enhance what they've written.

Students can be assigned to study a value, such as loyalty, by taking a photo to illustrate it and writing a poem or essay about the value. Even better, ask several students to take photos that depict a value or emotion, and then pair them up to compare or contrast their ideas. Visual stimuli can be particularly effective in sparking creativity in poetry and figurative language. Ask students to choose two photos of dissimilar objects or people and to write similes and metaphors describing how the two are similar.

VOICES OF EXPERIENCE

Tracy Coskie, associate professor
Western Washington University, Bellingham, Washington

Michelle Hornof, fifth-grade teacher
Alderwood Elementary School, Bellingham, Washington

Tracy and Michelle have a long-standing collaborative partnership. For more than 10 years, Tracy, a university professor, and Michelle, a fifth-grade teacher, have teamed up on projects in Michelle's classroom.

Little did our fifth-grade students know what they were in for when they took home digital class cameras during the first week of school. We certainly didn't tell them that their photos would later be used for a full-fledged, thesis-wielding, detail-loaded photo essay! Students rarely asked what to take pictures of. They just naturally took photos of things and people in their lives that were important to them, which were topics that later motivated them to write. These self-chosen topics eventually turned into their personal photo essays.

Once we got started, our photo essay unit took four weeks. We began by reading photo essays with the class so that they would have a vision of the genre. We analyzed these essays by identifying the thesis and supporting details in both photos and text. Students started writing about their own photos in Microsoft Word, learning how to insert photos and text boxes, cut and paste text, format text, add clip art, save and move files, undo mistakes, and many other computer skills new to our students.

Students then chose a working thesis: an idea or an opinion, not a fact or a question. They made sure they had enough photos to support their theses, and if they didn't, they took a camera home again or changed the thesis. They added text, making sure to include details in the writing that were not in the photos, ensuring that they were writing a coherent essay, not just captions. We then taught them how to write an introductory and a concluding paragraph and transitions between paragraphs. Students revised and edited with partners. They then reflected on their learning and goals. Finally, all students in the class published their photo essays by

Continued

posting them in a hallway and inviting parents, siblings, and other classes to view their gallery and meet the authors.

Three Tech Tips for Making Photo Essays Work

1. Students need time to explore the snazzy formatting features that computer programs allow before they can concentrate on the content of their writing. When we get frustrated watching students spend so much time "playing around" with formatting instead of writing, we try to remember that when we were first learning how to use Microsoft Word, we were also fascinated by all these fancy features—WordArt, page color, fancy fonts, clip art, and so on. And just like our students, we spent a lot of time just fooling around. Students should all be allowed this time of free exploration, especially if they do not have access to computers at home.
2. Each one teaches one. Teach one student a technology skill and then designate that student as the "tech expert" for that skill, responsible for teaching it to the other students, as needed. Conferring the title *tech expert* helps spread technology skills rapidly across the classroom, enhances students' confidence, and helps maintain smooth classroom management.
3. Plan to have two mini-lessons for the day: a writing lesson and a tech lesson. We usually taught a writing mini-lesson at the beginning of the writing time—for example, how to narrow your focus or add transitions. Then students described the lesson in their own writing. Then about halfway through writing time, we called the students together to demonstrate a new technology lesson. Sometimes we had a preplanned tech lesson, but sometimes the skill was based on the questions that naturally arose as students did their new writing for the day. Students then returned to their computers to finish writing. Both mini-lessons needed to be short because we did not want to take students away from their writing time.

Why We Taught (and Will Continue to Teach) Photo Essays

Students experienced the photo essays as exciting ways of understanding more about each other and themselves. They loved learning more about fellow students by reading their essays and studying their photos. They learned about themselves, such as Mark, who learned from writing his essay about building that he wants to be an engineer when he grows up. The essays also held poignant memories, like Betty's beloved guinea pig that died during the writing process.

Continued

Students learned about writing a thesis and a focused essay in a concrete manner because they used photos. For example, when they checked their essays to see if all of their writing matched the thesis, they could easily see whether each photo pertained to the thesis or was off topic. These skills transferred to other writing projects later in the year—and to the rest of their writing careers, we can hope!

Students became engaged in writing and editing their essays. Students were so engaged that they stayed in from recess, chose to write more photo essays after the unit was over, and only complained about writing when we did not have writing time. Even with a large class size and wide range of student writing abilities, hardly any discipline problems occurred, and every child was successful.

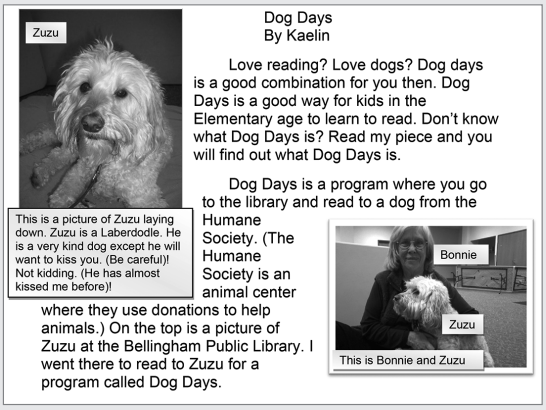

Figure 5.1. Kaelin, a fifth-grade student, created her photo essay about a public library experience.

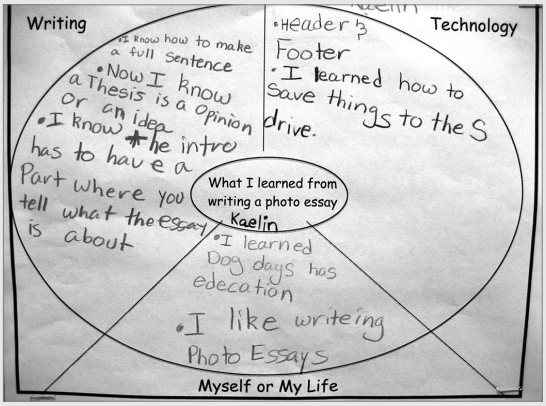

Figure 5.2. Kaelin's reflection of her photo essay.

Reimagining Shapes

Students can photograph shapes in their environment. This may be as simple as re-creating the alphabet with photographic illustrations (for example, a photo of a child's rake on its side with the tines forming the letter E) and as complex as finding advanced geometric shapes in architecture. Reimagining shapes excites students' imaginations and makes them aware of how marketing teams reimage shapes in advertising. A 2009 American Express ad shared by **TheInspirationRoom.com** (tiny.cc/bnkawy) showed common objects such as shopping bags and houseboats as though they were faces. Students' visual creativity is sparked when they reimagine one thing as representing another. For this project, students must synthesize and create, which sits at a very high level in Bloom's taxonomy.

Building Vocabulary

For regular vocabulary instruction, asking students to draw a visual representation of a word can be an efficient and effective strategy for building vocabulary. Occasionally, teachers may ask them to take photographs instead. One teacher knew that her students would find it difficult to draw or describe landform terms, such as *arroyo* and *butte*, critical for understanding geology texts, so she asked them to find photographs of Western landscapes and label their features. In another school, fifth graders celebrated Visual Vocabulary Day and came to school dressed as words. The activity automatically provided differentiation, as students were encouraged to choose words they considered new, unusual, or hard to remember. Students were photographed in their costumes and then created individual dictionary pages that featured their photos. The dictionary pages were printed for an in-class book project and collected into a digital slideshow to share with parents.

As with several other projects using visuals, teachers will need to assess the project's design to determine its level according to Bloom's taxonomy. Generally, the more teachers are involved in directing and controlling a project, the lower the project's requirements for students' higher-level thinking will be on the taxonomy. In contrast, increased student planning and control push the project to higher levels of thinking.

Creating Photo Essays

Photo essays are collections of pictures that tell a story. The story may be one of experience, dreams, advocacy for a cause, history, a science experiment, a day in the life of a person or animal, a nature observation, or any other topic that

captures a student's interest. Typically, photo essays, whether digital or made as a poster, include text in the form of captions that explain, expand on, or enhance the photos. These projects are excellent outlets for students who struggle to express meaning through writing, while pushing students into the highest levels of Bloom's taxonomy. Students synthesize what they know or imagine about a topic to create and communicate the story through pictures and words.

Resources for Photo Essays

You can gather more ideas and information about photo essays from the following resources.

Thompson, S. C., & Williams, K. (2009). *Telling stories with photo essays: A guide for PreK–5 teachers.* Thousand Oaks, CA: Corwin Press.

Thompson and Williams give multiple examples of and ideas for nine types of photo essays: historical event, personal history, nature experience, field trip, overcoming traumatic events, career, content integration, advocacy, and historical event interpretation. In the following explanation, these authors convey how students' photo essays capture their thoughts and experiences in ways that writing by itself cannot:

> Photography is a very powerful medium for expression. Individual photos speak to a reader in ways that words cannot. When a caption or short narrative is added, additional information and the photographer's intent in taking the photo become more available to the reader. In this way, children's photographs are like windows into their experiences and thoughts.
>
> A photo essay is a series of photographs that tells a story. One photographer can take the photographs that make up the essay, or several children can contribute to the collection. … Photo essays can document many things, including a historical event, a family's history, science experiments, a day in a career, observations in nature, personal experiences and interests, journeys, and field trips. When children create photo essays, they communicate their experiences and thoughts with readers in authentic and very personal ways. As readers, this personal communication helps us to better understand children, their stories, and their ideas (Thompson & Williams, 2009, p. 7).

Chick, K. A. (2006). Using family and community history to foster historical inquiry in the elementary grades. *Social Studies Research and Practice, 1*(2), 233–241. Retrieved from tinyurl.com/y73pjdx8.

In this article, Chick discussed the use of family and community history to foster critical inquiry. Learning about the past from conversations with older adults, students collected their participants' historical pictures and recorded quotations—by taking notes or, preferably, using audio or video recording with storytellers' permissions—to create photo essays. These projects, Chick said, allowed students to experience history as real people and events.

Recording Growth, Processes, or Change

Some processes, such as plant growth, evaporation, or seasonal change, are hard to see on a day-to-day basis. Photographs taken over time elaborate in a concrete way what statistical data show with numbers. This type of project is an excellent experience in the classroom, and it can be extended through free, online collaborative projects at **Annenberg Learner's Journey North** site (learner.org/jnorth). When teachers and students participate in collaborative data gathering and analysis projects such as these, students use higher-order thinking skills and become excited about math and science.

Often students waste time searching the web for the "right" pictures, only to find that nothing fits exactly what they imagined. When students realize they can photograph their own, more specific pictures with digital cameras, they free their imaginations from depending on images from the web. They can stage photographs that have all the elements they had imagined. Encourage the most eager students to explore the possibilities of photography, and soon they'll be leading the whole class into new ways of using digital cameras!

VOICES OF EXPERIENCE

Tracey Flores, Assistant Professor of Language and Literacy
University of Texas at Austin

Written from work alongside my third- and fourth-grade students and their families at Landmark School, Glendale, Arizona

As a teacher of culturally and linguistically diverse students, I have had the wonderful experience of working with phenomenal families who truly care about their children and their education. During my six years in the classroom, we have come together each year as a community of learners to work as a team to allow their children to achieve success, both socially and academically. There have been many gallery nights of shared writing projects, poetry readings, and end-of-the-year classroom celebrations. These family engagement experiences have allowed me to connect with parents and create important relationships that have opened the lines of communication between my families and me. However, although these experiences did get parents "involved in their child's learning" and bring families "into the classroom," I wanted to expand the types of family engagement opportunities I was creating with and for my students and their families.

The family engagement opportunity I envisioned would transform my practices from the past and create a safe space for families to come together to participate in a weekly writing workshop. The opportunity I envisioned would provide an equitable experience for parents to support their child academically by engaging families in authentic reading and writing experiences that honored and centered their cultural, linguistic and familial resources. Each family's home literacy practices would be explored and used as a foundation for reading and writing experiences that we would share as a community of readers and writers.

As part of the school's efforts to bring the community together and my desire to build relationships with my students and their families, I created and implemented The Family Writing Project as part of my classroom learning community. It started at the beginning of January and lasted until the end of March, 2011. It convened for 10 weeks, once a week for an hour and a half after school. The participants were students in my third- and fourth-grade English Language Development (ELD) classroom and their families.

Continued

Each writing workshop began with a mini-lesson, writing and drawing time, and an author share time. Mini-lessons consisted of drawing neighborhood maps and reading and discussing culturally sustaining children's books that connected to families' lived realities. Every family writing workshop was facilitated in English and Spanish, with parents helping to translate for the entire group, and students translating for their parents in their writing partnerships. Families were encouraged to read and write in the language that was most comfortable to them, and all attempts at writing were honored.

Participants chose one piece of their writing to take through the writing process. With the support of their family writing partnership, facilitated as part of The Family Writing Project, their self-selected writing pieces were revised, edited, and then published on the computer, using Microsoft Word. Then, all writers worked with Frames, a digital storytelling program, to create images using various media to accompany their stories. Writers were encouraged to choose from the program's premade backgrounds, bank of images, and sound media. However, many chose to start from scratch and invented a unique digital story from their lived experiences with images of their own creation.

The program was very accessible to each participant, and with the support of the computer teacher and myself, writers designed a variety of scenes for their digital stories that also included their recorded voices telling their stories in English and Spanish.

• • •

Creating Visuals

Pictures and drawings are not the only visual media students create. Charts, graphs, and graphic organizers also help students visualize ideas.

Avatars

On some websites, such as wikis or blogs, students may want to post "pictures" of themselves as identifiers. Online safety eliminates photos of students under the age of 13, so elementary students need other sources for avatars. One option is for students to draw self-portraits in a drawing program and save their portraits.

Another option is to use an avatar creator site. **Portrait Illustration Maker** (illust-maker.abi-station.com/index_en.shtml) does not require registration and lets students make choices about hair, eyes, face outlines, eyebrows, nose, mouth, and skin color. The icons students create are downloadable as files. The saved files can then be uploaded to documents or to online profiles.

Note: Students must complete their avatars in one sitting. If the site comes up in an unfamiliar language, click the language button on the top right.

Similarly, the **Mini-Mizer** (reasonablyclever.com/mini/flash/minifig.swf) uses forms that look like Lego pieces to create characters. Students will need to use the Print Screen options to save their pictures.

Secondary students can use drawing programs to create more sophisticated avatars, if desired, although some may enjoy the avatar-maker sites.

Annotations

Annotations and highlighting break up text into visual clusters, which appeals to visual learners. Digital tools promote crowdsourcing the close reading of text. When students collaborate on text analysis, they learn from one another. Then, too, teachers can assess students' understanding and determine where future instruction should focus.

Prism (pedagogy-toolkit.org/tools/PRISM.html) is a way for teachers to have students highlight a common text and then aggregate all the versions into one text. Teachers must upload the text and invite students to participate by sending the private link in Prism. Students can use different colors of highlighters for specific purposes (e.g. red = confusion; blue = imagery). Effective highlighting is not intuitive, so teachers may need to model the skill before they have student pairs try it out. This tool could be used in any subject area where students practice close reading.

Edji (edji.it/#/home) is an alternative to Prism with slightly different features. Teachers create classes and invite students to annotate documents, the same as in Prism. But students use text or emojis for their annotations. When passages have more than one annotation, the color adjusts from yellow to red. A Hero subscription unlocks additional features, such as audio notes and teacher-added questions to provoke higher-level thinking.

Hypothesis (web.hypothes.is/education) provides the opportunity for annotating any webpage through an extension downloaded to the Chrome browser. Resources on the site show teachers how to use the extension tool for annotations of webpages and PDF documents. Students could use the tool to identify how they have explored a site's credibility (a key practice for digital literacy), identify facts versus opinions in a digital text, or even annotate an online image as part of media literacy.

NowComment (nowcomment.com) was originally designed to promote discussions of online documents and has filtered to the K–12 sector. Teachers can sign up for a free account and then create "Managed User" accounts for their students (instructions at nowcomment.com/help/managed_users). Teachers upload documents to their accounts and invite students to annotate the document. Teachers and students can read the comments or embedded pictures or videos tied to the relevant text.

Word Clouds

Students enjoy taking their writing pieces and creating word clouds based on frequency counts. **Wordsift** (wordsift.com) and **Wordle** (wordle.net) generate word clouds based on text entered into the text box on the site. The sizes of words in the clouds are based on their frequency counts in the text, minus the most common words such as "the." Word clouds can be especially helpful for ELLs; students can readily see which words are most important in a text.

Teachers have generated lots of ideas for using word clouds with students. One classroom teacher had middle-school students write on the topic "Honoring Veterans." After students had finished their essays, they pasted their texts into Wordle to create word clouds. They then were challenged to be thoughtful about the colors, fonts, and shapes they chose for their clouds. For their end products, they created slides of the word clouds with explanations of their choices, followed by slides of the essays themselves. When the slideshows of all students in the class were combined, students could see how the words in their clouds reflected different themes in their essays. This project turned a fun tech tool into a higher-level thinking tool.

As a research project in a graduate program, a team of students compared websites by pasting the texts of the home pages into a word cloud. The word clouds helped them see what values the webpage owners promoted.

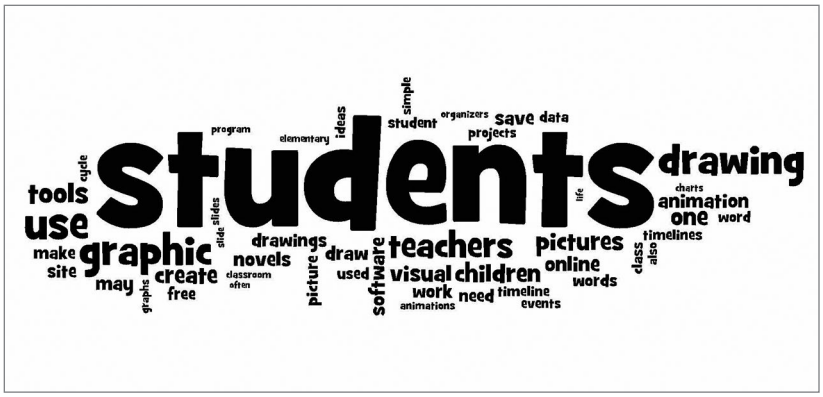

Figure 5.3. This visual, created by the author in Wordle (wordle.net), captures the most common words used in the current chapter on leveraging visual technologies. Words in the visual are sized by frequency of use and suggest what is most important in the text.

Graphic Organizers

Visual students build their understanding of content through visual organizers, and these are easy to create on computers. Examples of graphic organizers can be found in any internet search. In addition to the common spiderweb graphic, students can try cause-and-effect charts, story maps, bubble maps, t-charts, and compare-contrast graphs.

Some teachers use commercial graphic organizer software, although students can use shapes in any presentation software or word processor to create graphic organizers. Often blank slides work better for design than word processors.

Students can also use an online graphic organizer for creating mind maps and brainstorming. The advantage of student-designed graphic organizers over predesigned ones is that students can better represent their thinking when they control the design. In fact, one goal of using graphic organizers is to stimulate students to independently design visual diagrams as thinking tools.

Popplet (popplet.com) was created for ages 13 and under and is available online or for the iPad. To register online, students must have email accounts, but they do not give unnecessary information and they choose their own passwords. The interface is easy to master.

ReadWriteThink also has several graphic organizer tools. The **Webbing Too**l (rwtinteractives.ncte.org/view_interactive.aspx?id=127) can make cluster, cause-and-effect, and hierarchy webs. Typically, tools from ReadWriteThink are student-friendly and can be printed or saved. Lessons plans for using the ReadWriteThink Webbing Tool span Grades 3–12.

Although students can use graphic organizers as a planning step for projects, mind maps or webs can also become the final products for a learning cycle. In one third-grade classroom, students in study groups researched immigration from different countries. The teacher ended the study by using the jigsaw method to make expert teams with one child from each study group. The expert teams then created diagrams to compare and contrast the immigrants from the countries they'd studied. The conversations students had as they designed their diagrams surpassed any whole-group discussions during the unit, and the teacher never could have settled on only one design that would have honored the divergent thinking within her class.

Flow Charts

Introduce students to engineering by teaching them to create decision-making flow charts. These graphic organizers give students practice with analysis, which is at the fourth of six levels of Bloom's taxonomy. Using Shapes in any productivity suite such as Microsoft Office, OpenOffice, or Google Docs, students can design flow charts. Online webbing tools also have flow chart capabilities.

Big questions are used as titles. Smaller questions are written on diamond shapes, and possible answers on individual squares or rectangles. Arrows connect the diamonds and squares. Answers may consist of yes/no or may be specific to the situation. If there are conditions that influence the decision, the conditions can be written on the arrowed lines. An answer may easily lead to a second question, which has several possible answers. Sample big questions for flow charts include the following:

- What are the steps for solving a math word problem?
- How can you tell living from nonliving things?
- How do you know whether you can use an image in a slideshow that will be made public?
- How do you troubleshoot a computer problem?

- What are the implications of a decision (on any topic)?
- How do you choose an independent reading book?
- How do you respond to a bully?

Flowcharts can also be made with free digital tools. With **Gliffy** (gliffy.com), students can make flowcharts, graphic organizers, and other technical drawings for free. Students over age 13 can create an account first and then request a free single user license. Otherwise the site requires a paid subscription. NCH Software offers free, downloadable ClickCharts diagram and flowchart software (nchsoftware.com/chart).

Decision trees can be made for free on **Canva** (canva.com/graphs/decision-trees) using one of their templates. Although the online tool is free, registration is required. Teachers and parents are permitted to allow students on the site *provided the students are directly supervised by the adult*. Canva's decision trees can include photos.

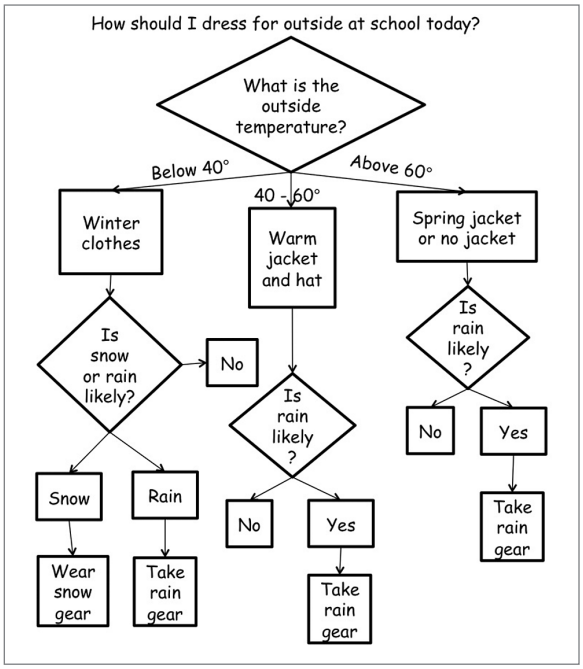

Figure 5.4. Decision Flowchart.

Timelines

Students can use timelines to track the sequence of events in books or historic events. On other occasions, teachers may want students to make connections among events that seem disparate. Timelines can help. For instance, students in one class were reading biographies of famous people; they used a class timeline to look for overlaps of their subjects' life spans. Students in another class used timelines to plot the events of the colonization of America. To dramatize an event, students can combine dates, photos, audio, and video clips in a slideshow. To view a professional example, see **The Sesame Street Timeline** (youtube.com/watch?v=Cz4JPszHnZM).

Commercial timeline software never seemed worth the price at my school because teachers simply did not create enough timelines for the software to pay for itself. Online timeline generators suitable for elementary students, however, have limitations that make them less attractive than commercial software. The really good, free, online timeline generators restrict users to individuals over the age of 13.

Secondary students have many choices of good timeline generators. Consider having students create timelines in word processor tables, spreadsheets, or presentation software. In the following list of resources, free timeline websites come first, followed by online help for creating timelines.

The National Council of Teachers of English provides a number of online interactive tools for students at **ReadWriteThink**. The **Timeline interactive** (readwritethink.org/files/resources/interactives/timeline_2) is particularly easy to use with students who have limited technology skills. Two features limit the tool: Students can use words but not pictures in their timelines, and the timelines cannot be saved, so they have to be finished in one sitting. Students can print their timelines horizontally or vertically.

Teach-nology (teach-nology.com/web_tools/materials/timelines) provides two simple timeline tools: a vertical timeline that shows up to nine events and a horizontal timeline that shows up to six events. This tool has the same limitations as those developed by ReadWriteThink.

Microsoft Office has acquired a free online timeline maker called **Pincello** (pincello.officetimeline.com), which allows users to build timelines from scratch or from Excel data. Timelines can be downloaded to PowerPoint or as an image. No logon seems to be required to create or download, although saving may require an

account. Microsoft also offers an **Excel Timeline Template** (templates.office.com/en-us/Timelines).

Preceden for Teachers (preceden.com/teachers) has free teacher accounts, but this is one of the rare occasions when I advocate paying the $29 annual subscription fee if students will be making multiple timelines. With subscriptions, teachers can create student accounts, have unlimited numbers of timelines with unlimited entries and photos, and save student work. The step-by-step instructions on how to use the entirely web-based site are excellent; all you need is access to the internet. You can even layer multiple timelines so that students can see how the events and dates on their timelines intersect with other timelines. Of all the timeline software options, this one provides the greatest flexibility.

MyHistro (myhistro.com) is for students over age 13. MyHistro timelines integrate text, video, and pictures with maps to create digital stories. Students can collaborate on the timelines as well.

Graphs and Charts

Teachers are not as likely to have experience with spreadsheets as with other productivity software, but spreadsheets are not difficult to master. For beginner graphing experiences, classes often use colored candies or cereal. Students sort their small containers of bits by color and enter the data in a table. The table can then be converted to a graph. The exercise itself has little need for a graph because students generally can tell from looking at the data table which color is more plentiful. To extend the activity, ask students to predict what the results will be if they combine all the data into one graph. Which colors will predominate? Which will be less common? Then collate and graph all the students' data. How did the greater total number of objects affect the graph results? If a teacher combines data from another class to increase the total number again, students can predict the final outcome and then test their hypotheses. In collaborative spreadsheets, such as Google Docs, students can simultaneously enter their data individually onto separate columns. The rows of the data table can then be added and the data totals graphed.

At the secondary level, students can conduct surveys or collect data from science experiments. Middle- and high-school students should be able to use digital spreadsheets, although they may have limited experience with graphing.

Of critical importance for teaching graphing skills is the conversation about what the information shown by graphs means. Weather data provide excellent opportunities to examine differences among cities and countries. In one class, students used a spreadsheet template with the local average monthly temperatures already entered. Each student visited **Weatherbase** (weatherbase.com) to collect data on a city in another country and created line graphs that compared data from their own city to data from the other city. Students set the y-axis range of their graphs to span the coldest and hottest temperatures in the class so all graphs used the same range and could be compared. The best learning took place when students compared all the graphs. Temperature patterns revealed the global positions of the cities and the surprising fact that equatorial cities, which maintained consistent temperatures year-round, were colder than cities outside the equator during some months. Data about precipitation helped students predict habitats in various parts of the world.

A fifth-grade teacher, aware of her students' fears about the transition to middle school, asked them to create a survey for middle-school students, conduct the surveys, collect data, and graph the responses. When they saw that sixth graders had not been shut in their lockers and, in fact, liked middle school, the fifth graders' fears were allayed.

Students may generate other topics for which they create and administer surveys. For elementary students, surveys typically must be printed because online survey sites do not permit students under age 13 to generate or respond to questionnaires at their sites. Secondary students have access to online survey applications, such as **SurveyMonkey** (surveymonkey.com) and **Zoho Survey** (zoho.com/survey). The advantage of an online survey is its time-saving feature that tabulates results automatically. Teachers and students can concentrate on discussing what the results mean.

Several online tools can be used for graphing data as a whole class or for generating graphs for students' projects. The following tools are worth exploring.

Create a Graph (nces.ed.gov/nceskids/createagraph) is a government site where data can be entered and represented in different graph forms. The website also offers graphing examples based on government data and a tutorial on how to create a graph.

Using **Chartle** (chartle.net), students can make simple graphs and charts, interactive charts, and unusual graphic representations of data online. No registration is required.

ChartGo (chartgo.com), a graph maker tool, does not require registration. Data can be uploaded from Excel or as a .csv file. Students set the parameters and choose chart or graph types. The charts and graphs can be embedded on a blog or wiki, or downloaded to a computer.

DIYcharts (diycharts.com) is a new free charts and graphs tool that can be used without registration. The site offers 11 chart types and data can be typed live or imported from Excel.

Graphing Calculators

Secondary math teachers sometimes use digital tools for graphing functions. If your students cannot afford graphing calculators, free online tools can fill the gap.

GraphFree (graphfree.com) does not require registration and claims its capabilities exceed those of some graphing calculators. Teachers can also print blank graph paper on the site.

GeoGebra (geogebra.org) has a number of math apps and classroom resources. In addition to a graphing calculator, there are tools for geometry, 3D graphing, and augmented reality (for iPad and iPhone). The tools can be used online or downloaded for offline use.

Desmos (desmos.com/calculator) has a graphing calculator that students can use without signing in, but the better choice may be for teachers to create accounts in Desmos Classroom Activities (teacher.desmos.com). On the site are bundles of lessons using Desmos tools for different types of math explorations. Desmos can be used by students under age 13 with teacher accounts.

Sketchometry (sketchometry.org/en/index.html) converts hand drawings into geometric constructions. The app works on all platforms and interactively online. The tool is still under development.

Maps

Scribble Maps (scribblemaps.com) combines Google Maps images with the tools to scribble, draw, add text, insert place markers, and embed pictures on the map. The site is restricted to individuals who are at least 13 and have parental permission or are 18. In elementary classrooms where teachers could register, students could, as a whole-class activity, track **Flat Stanley** (flatstanleyproject.com) or other literacy and traveling projects, identify the locations of Skype partners, or follow the Iditarod trail. Individual students might re-create the journey of an historic figure, locate U.S. presidents' birthplaces, or identify landmarks in a country under study. Marked maps can be saved as images.

Another mapping tool, provided by National Geographic, is **MapMaker Interactive** (mapmaker.nationalgeographic.org). World and national maps can be marked to trace a journey, as in the books *Letters from Rifka* by Karen Hesse or *Around the World in 80 Days* by Jules Verne. Maps can be saved as editable files, so that the class members can continue to refine their maps as they progress through the books. In history classes, students can map migration paths or explorers' trails.

Cartoons

Creating cartoons causes students to narrow an event to its essential parts, which requires high levels of thinking. Good cartoons tell as much through pictures or drawings as through the words. One fourth-grade teacher has her students use clip art, photos, and shapes in slideshow software to create their own comics. Resources to demonstrate how to use slides for comics can be found in the Google Apps User Group discussion board under "Creating Comic Strips with Google Slides" (controlaltachieve.com/p/session-comic-strips.html).

Cartoons need not be funny; often comics carry weighty messages using irony or satire. Students can use comics to express viewpoints, explain concepts, review books, tell (or retell) stories, present facts, outline processes, or sequence events. Cartoons can be integrated into science or any other content area through explicit teaching about puns and other wordplay. "Humorous Cartoons Made by Preservice Teachers for Teaching Science Concepts to Elementary Students: Process and Product," an article by Rule, Sallis, and Donaldson (2008. scholarworks.uni.edu/oermaterials), includes an appendix with 24 slides of humorous science comics made by preservice teachers. There are two comics per slide with the science explanation beneath each slide. The article is free and appropriate for teachers to review

to spur creative thinking about what students could do on other topics. This may be one time when clip art is an effective medium for conveying a message.

MakeBeliefsComix (makebeliefscomix.com) is free and geared toward children. A limited cast of multicultural characters and palette make this an easy-to-master tool. (Users need a Flash Player 10 or above.) The printables and lesson plans on this site are incredibly helpful for elementary teachers. Finished cartoons can be printed or emailed, but not saved. Students may write talk balloons in English, Spanish, French, German, Italian, Portuguese, or Latin. The site has a Special Needs section with ideas and tips from those who work with special needs students.

Write Comics (writecomics.com) is a simple online comic strip creation tool. Character choices are limited and include few people of color.

ToonDoo (toondoo.com) requires registration but is free. Students under age 13 are not permitted to register.

Toony Tool (toonytool.com) provides a limited palette of backgrounds, characters, dialog bubbles, props, and text boxes for creating one-panel cartoons. Users can also upload their own images. The finished products can be printed, emailed, downloaded, or shared online. The tool is free, does not require registration, and so is suitable for all students. Toony Tool would serve as a simple introduction for younger students and a great base for political cartoons at the secondary level. The site hosts other tools, such as word clouds, photo collages, and a photo enlarger, to name just a few. It is worth exploring the entire site because the tools are intuitive and don't require registration.

Comics Head (comicshead.com) is a free iPad app. The tool provides templates, animation, and many options in the resource area. The site does not list age restrictions.

Storyboard That (storyboardthat.com/storyboard-creator) requires a subscription after a 14-day free trial, but its education edition offers a lot of teacher support as well as good options for students. Teachers can choose to pay for only one month, provided they remember to cancel before the month is up, so it is possible to do one good project at a reasonable cost.

Although Storyboard That is listed here as a tool for cartooning, like many digital tools in this book, it can be used for many purposes. Dr. Brent Hollers described

how his students took advantage of the potential in Storyboard That for a different kind of visual representation.

VOICES OF EXPERIENCE

Brent Hollers, PhD (bhollers@btcatholic.org, brenthollers.com), teacher and instructional technologist
Blessed Trinity Catholic High School, Roswell, Georgia

Visual representation and drawing of ideas is often a difficult, but rewarding, activity for students. This is especially true when dealing with complex calculations, tasks, or processes. In a course called Introduction to Engineering, we attempt to expose students to various engineering disciplines while introducing relevant and grade-appropriate math and science concepts. This can often be a difficult task, especially considering some of the complex topics covered in the various fields of engineering.

One such topic is chemical engineering. We wanted the students to develop an understanding of basic chemical properties while being able to design a solution to a problem or design challenge they may face. In order to make the unit more relevant and hands-on, we built a biodiesel plant that turns the school's waste grease from the cafeteria into diesel fuel. This fuel then runs the school's tractor and other diesel-powered vehicles. This conversion requires multiple steps to complete and involves students grasping some difficult chemistry concepts. As we completed the lab, we found that students were unable to clearly articulate the steps that had been taken to create the biodiesel fuel. To help with this, we asked the students to create a visual representation of the process, explaining each of the steps and their chemical underpinnings. To do this, the students used a tool called Storyboard That (storyboardthat.com). This tool allows students and teachers to create storyboards (or as I refer to them, comic strips) with a variety of built-in characters, scenes, props, and shapes. In addition, it allows the user to bring in outside images to add to their storyboard. What makes this tool so powerful is its ability to allow students to create unique, engaging visual representations without a need to be a great artist. As I often tell my students, drawing a stick figure for me is somewhat of an accomplishment, so I was immediately drawn to a tool where

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drawing skill was negated and students could create more quickly and simply. This also serves as a tool for differentiation because it allows you to level the complexity of the storyboard to that of the students by requiring more cells (areas of content) or more detailed drawings, or even having them create their own unique layouts for the storyboard.

While this was designed as a review of the biodiesel process, it quickly took on a life of its own. Students were so proud of what they had created and were interested in seeing others' unique designs and interpretations of the biodiesel process. This led to an exhibition of the students' work using Google Classroom. The students turned in their completed work (without their names) to Classroom. I then combined them all into a single Google Slide Deck with a number in the corner. Students then viewed each drawing and chose their three favorite storyboards (this was done using the Poll Everywhere extension in Google Slides). The winning storyboards were then printed in poster format and hung in the lab by the biodiesel plant as an exemplar, review guide, and explanation of the process all in one. This project not only created improvement in student understanding of the biodiesel process, but also added an element of creativity and fun without the need to be an artist.

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Graphic Novels or Short Stories

Increasingly, teachers are becoming aware of how graphic novels intrigue visual learners as reading materials. Graphic novels also benefit students who are learning English because the pictures carry so much of the storyline. Consider the level of inference students must use to "read" the pictures in a graphic novel!

Graphic novels can be engaging and challenging for students to write as well. For students who struggle with words, graphic novels can help them express their own complex ideas, including various characters' emotions, motivations, and shades of meaning, that these students are not equipped to express using words alone.

I use the words *graphic novels* loosely when discussing student products. A true graphic novel would require more time and expertise than could be expected at the elementary or even secondary level among most students. Instead of full-length novels, students can produce short graphic stories, like simple comic books, that tell fictional stories, retell stories they've read, or review historical events.

VOICES OF EXPERIENCE

Sally Brown, Associate Professor of Literacy
Georgia Southern University, Statesboro, Georgia
SallyBrown@GeorgiaSouthern.edu

Graphic novels can serve as important scaffolds in reading comprehension for English language learners because of their visual nature. I decided to engage a diverse group of second graders in a nine-week inquiry centered on graphic novels. The inquiry began by immersing students in reading and listening to read-alouds of graphic novels, like *Babymouse: Queen of the World!* (Holm & Holm, 2005). At the beginning of the experience, I started a class blog to document student learning. Each child created a fake name to use on the blog to protect student identity. I used **Edublogs** (edublogs.org) because of all of the security features of the site. I met with excited students in small groups as they devoured these captivating books. Lessons were planned to guide students' exploration of text features, such as panels and speech bubbles. As students learned the basics, they started experimenting with characters' voices as they read books in the same series. Other students investigated a multitude of books to help them get a sense of story elements, such as setting, problem, and solution. In all cases, students concentrated on the visual elements of graphic novels to gain an understanding of the storyline.

After four weeks of reading, I moved the focus to writing. Each student wrote a graphic novel. Students were buzzing with ideas for their stories. Some of their ideas came from the graphic novels they had read, and others were from cartoons or personal experiences. To begin the process, the students brainstormed on paper about characters, settings, problems, and solutions. In addition, they drew draft images of their characters. Once they had a working idea, the students began drawing their graphic novels. They could choose from several blank papers with frames in varying configurations. The pencil drawing occurred before the writing to aid with construction of a meaningful storyline.

When students were finished illustrating the entire sheet, they wrote their draft texts on small Post-it notes and placed the notes in the appropriate speech bubbles. In one-on-one conferences, the students and I edited their writing on the Post-it notes

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for spelling, grammar, and punctuation. After the entire page was ready, students traced their images and wrote their words with a fine-tipped black marker. Students continued creating their novels over the course of about three weeks. The last step in the writing process was coloring the images with colored pencils.

Upon completion of the paper copy of the graphic novel, students moved toward the digital version, using Microsoft's Photo Story 3. This software was chosen because it is free and very easy to use. I scanned each student's graphic novel and loaded their files onto one of the three classroom computers. The students took over from there. They easily learned how to upload their images, add titles, record their voices, and embed music in their videos. I taught the first student the process, and then that student taught the next student. The project culminated with an authors' celebration: Each digital graphic novel was played for the class, and students wrote comments about each other's stories. To see the journey and final graphic novel projects, go to exploringgraphicnovels.edublogs.org.

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As with cartooning, students need a plan prior to commencing their graphic stories, but unlike cartooning, creating graphic stories requires entire storylines. Ideally, students use storyboards to plan their ideas for graphic novels, so they can review their stories with peers to identify any aspects that may be missing or confusing. Illustrations can be hand drawn or computer based. Depending on prior experiences, students could stage props to photograph for their novels.

Advanced students might combine photographic backgrounds with clip art and hand drawing in a drawing program. Fourth- and fifth-grade students at my previous school often pasted background photos and clip art into a drawing program; then they used the drawing tools to add details. They would save the mashed-up pictures and import them into presentation slides. In the slides, they used shapes to make speech bubbles and added text. This was not something teachers taught—students discovered how to adapt the drawing program themselves and taught one another. Secondary students could easily replicate this.

Graphic novels or short stories can be produced in several venues mentioned throughout this book: slideshows, digital storytelling apps, online book creation sites, or word processing programs. Use the tools that are comfortable for your

students. Ideas for graphic books or stories should not be limited to fiction. Think about graphic nonfiction articles that explain concepts in content areas or make local history accessible to younger students. These could be bound (or converted to ebooks) to be part of the school library's collection.

Animations

Although most teachers will consider animations too difficult for whole-class instruction and exploration, I've included this topic for those who love to challenge themselves with technology. Animation can be exceedingly engaging and fun. Improvements in technology have provided more intuitive tools than in the past. Some online tools and apps blend storymaking, videos, and animations on their sites. I limited the list to easier formats. Explore the simple sites first and then do an online search for more advanced versions.

Children are fascinated with the potential of animations, but the task of making effective animations requires patience and knowledge of how animations work. Some free programming software packages, such as **Squeak** and **Scratch**, can be used to program animations, but few teachers have the skills, or the interest in building the skills, or the time to teach programming code successfully. Instead, I suggest that teachers direct students to online animation sites, which provide the tools to play drawings at high speed to simulate changes. When drawing images for animation, students learn that changes happen slowly over several frames. Before trying animation sites, students need to know the four ways images can change:

Size. An image can be made progressively larger or smaller.

Shape. The shape of an image can be progressively altered until it becomes something else.

Position. The location of an image can be changed to create the illusion of movement.

Addition/subtraction. On each page, adding or subtracting part of an image creates the illusion that an invisible hand is drawing or erasing the image.

Students need several opportunities to try out animation tools before they begin to master the skills. Their first experiences will probably result in poorly executed animations, but they will learn through their failures. The technical and art aspects of animation require a lot of cognitive skill, so before they begin, students

should have a simple plan for their projects in mind, perhaps including a storyboard. They could illustrate a (very!) short story, simulate a chemical reaction, or show an electrical current lighting a bulb. Consider demonstrating the water cycle or life cycle of a plant or how simple machines work. The animation tools students use will determine the complexity of their animations.

The resources available for student-generated animations range from sites where students direct the animation but do not need to understand the technical aspects to tools where students do all the work of creating the sense of motion. At first, students need to explore a few tools to learn how they work.

Many animators started with flipbooks. The New York Film Academy has an article about various types of flipbooks that are possible (tiny.cc/0eyawy). Several animators have also made YouTube videos of their flipbook practices. This may be a good starting point for understanding flipbooks and how they contribute to computerized animations.

Flipbook (benettonplay.com/toys/flipbookdeluxe) has simple, intuitive drawing tools but it does require Flash, which limits its use in classrooms. Students need to know that they are creating each slide of the animation. Since the slides flip quickly, changing something in every slide actually makes the animation jumpy, rather than smooth. Students should insert two or three identical slides before they make any slight change to the next slide. This simple rule will improve the animations significantly. Guests are allowed to create flipbooks of up to 100 frames without registering; flipbooks made by registered users are shown in a gallery on the site.

ABCya! Make an Animation (abcya.com/animate.htm) provides drawing tools and colorful clip art for animations using Flash. Students can upload their own pictures for the background, adjust the frame rate, and make up to 100 frames. ABCya! is a great site for teaching students the fine art of animation. The tutorial on the site introduces the tools and potential of animation. Creating animations represents Bloom's taxonomy at its highest level.

PowToon (powtoon.com/edu-home) has an educator site that allows secondary students and teachers to create accounts. Many of the services are free, although the final products are watermarked and download as PDF or PPT. Student and teacher accounts are available at an annual cost. With a teacher subscription, this site could be used with elementary students. Take a look at the Tutorials page to see what the site offers for your students.

Flip Anim (flipanim.com) does not list age restrictions on its site, and students can make flipbooks without registering. But in order to save or publish, students need to register for the site with an email address. When flipbooks are saved and made public, creators must indicate if the animation is for viewers over age 18.

Augmented Reality

The use of augmented reality is making headway into schools and classrooms. Augmented reality, known as AR, is the use of technology to enhance what you see in reality. This differs from virtual reality (VR), which is the projection of a computer-generated environment where a viewer is immersed in and interacts with the environment.

AR experiences require the use of smartphone cameras or tablets with cameras, such as iPads. Secondary students are more likely than elementary children to have the smartphones in their pockets. Teachers with iPads will be able to participate in AR experiences. If a teacher has only one or two iPads available, consider making the use of AR a center in the classroom or presenting the AR experience to the whole class through a document camera and projector.

Augmented reality is when technology is used to superimpose information on the real world. The information may be text, images, sounds, or video. **Pokemon Go!** is an example of AR, as is **SkyView Free** (play.google.com/store/apps/details?id=com.t11.skyviewfree), a stargazing app that uses your phone camera to locate and identify objects in the sky. When televised sports use colored lines to mark the line of scrimmage or arc of a soccer ball or hockey puck, viewers are seeing AR in action.

For the purposes of this book, the discussion will be limited to marker-based AR, even though other types are being developed. Marker-based AR requires a special visual object, such as a QR code or special signs, and a camera to scan the visual object. Often the markers will be downloaded and printed, but some markers are on -screen. When a smartphone or table camera is pointed at the marker, the viewer will see an augmented object, such as a 3D model of the Eiffel Tower or a rhombus; text, like descriptions of a country's topography; or a video, such as a book trailer. Teachers can provide AR experiences for students or can involve students in creating their own AR objects.

AR Sites

In her Voices of Experience write-up, teacher Lula Garcia identified several AR apps she uses with students. I've listed a few additional apps, and I recommend you visit **EdShelf** (edshelf.com) and search for *augmented reality*. You'll find teachers' shelves of AR apps they like.

Blippar (web.blippar.com/augmented-reality-for-education) is an AR creation tool as well an as an AR resource. Free basic accounts have limited features. Educational pricing is available but not evident on the site.

Arloon (arloon.com/en) has created three elementary (Mental Math, Plants, and Solar System) and three secondary (Geometry, Anatomy, and Chemistry) AR apps to be projected onto free Augmented Reality Cards printed from their website. The apps are available through iTunes and Google Play. Each app costs about $3.

Shakespeare's Globe 360 (shakespearesglobe.com/discovery-space/globe-360), an iOS app, provides a 3D experience with the Globe Theater. The experience includes video and photo galleries from Globe Theater productions.

VOICES OF EXPERIENCE

Lula Garcia, Middle School Science Department Head
American School of Tampico, Tamaulipas, México
lulagarciamtz@gmail.com, @Cabraliega

Would you like your students to experience WOW moments in your classroom? Have you ever imagined how amazing it would be to bring real fossils into your classroom to enrich your lessons? Or having volcanoes explode on each and every student's desk? I have been teaching science in middle school for 10 years. Teaching science requires planning not only classroom lessons, but also lab activities which enrich what's learned in the classroom. My students have exploded volcanoes, danced with skeletons, and studied the layers of the Earth, all with virtual models that they can manipulate individually and at their own pace. I have been transforming my lessons into engaging experiences using AR for two years now.

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Students are naturally curious and creative. Teachers are always looking for original ways to challenge students and engage them into learning. The use of AR in the classroom transforms your lessons into fun and highly interactive but also relevant and meaningful experiences; this causes a major impact in our students, who learn the content faster and with a deeper comprehension. Students get to experience and manipulate virtual models individually, giving them the freedom to make observations and look for precise details as they expand their curiosity exploring the model assigned for a specific lesson.

Integrating AR into your lessons, no matter your subject area, couldn't be easier and will motivate your students. There are many amazing apps where the images look so real, students won't believe it is a virtual experience. Here are a few of my favorite apps:

EON Experience (eonexperience.com): Although this app has tons of material (educational or games) to choose from, I have only used the eye and the solar system experiences. It has the option to choose from using AR or VR (virtual reality) mode for which you need VR goggles. Using this app requires a marker—without it you won't be able to load the AR mode.

Quiver (quivervision.com/apps/quiver-education/): Quiver has some free educational activities to enrich or introduce animal and plant cells. My students enjoy the volcano worksheet. In order to use this app you have to print a coloring page and scan it with your phone camera through the app. It will then load a 3D model that becomes interactive and informative as you use it.

HP Reveal (studio.hpreveal.com/landing): Formerly known as Aurasma, this app allows you and your students to create original experiences called Auras through visual interactivity. It attaches a virtual experience to a printed object or paper. Bring printed pictures to life using your phone or tablet. Your students can create their own clips and attach the video clips to a picture for everyone to look at using the camera in the app.

Merge Cube (mergevr.com/cube): This "toy" has been an asset to my science classroom. Students became interested and engaged in the activities as soon as I told them what it was going to be used for. Although it has more games and just a few educational experiences, the brain and the heart can be observed with such detail that we didn't have to buy real ones for our lab

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activity. It also included a very complete and well-designed Solar System in which students can interact with each of the planets and learn interesting facts about all of them. (Read "The 10 Best VR Apps for Classrooms Using Merge VR's New Merge Cube" (tinyurl.com/ycjthkly) to understand what the cube is and how it works.

ARVIZ (su2crcdm.org/app): This app for Android or iOS devices allows students to interact with culture and heritage in 3D and 360-degree pop-up artifacts. Just download a booklet with pictures of the artifacts, and once the camera points at the page, a 3D object that automatically rotates 360 degrees, simulating a museum exhibit, will appear for you and your students to analyze and make observations about.

Metaverse (gometa.io): This is a free AR platform where students can create their own experiences in a storyboard to which they will add screens and activities. Teachers can even create quizzes, include clips from YouTube, and ask questions about the clip. It becomes an interactive and personal experience for each one of your students.

ThingLink (thinglink.com/edu): Teachers and students can create experiences on the web and visualize it using the app. Users can travel virtually anywhere in the world. Both, teachers and students can create and edit images and 360-degree tours, producing engaging and amazing experiences for everyone.

I encourage you to enrich your lessons with augmented reality. Students will be amazed and totally engaged in your lesson that will become their own experience. Depending on the content and the experience, you will find apps with prices that range from free or low to very expensive. Anatomy apps mainly used for medicine are among the most expensive ones.

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Virtual Reality

Virtual reality (VR) is considered by many to be the next great advancement in education. Others consider it still too expensive and experimental to provide much beyond the "Wow!" experience. Unlike AR, most current uses of VR will be dependent on budget windfalls and cooperative IT staff to assist a teacher with implementation. Internet searches on the pros and cons of VR will highlight

both the benefits for students and the cautions teachers must consider. The Tech Edvocate published "20 Top Virtual Reality Apps That Are Changing Education" (tiny.cc/0kyawy), which may be a good starting place for your exploration of VR.

Instructing with Visuals

Teachers can use visuals for instructional purposes as well. For instance, when students are prereaders, photos can reinforce expectations, such as how the room should look at the end of the day, the procedures for borrowing a book from the classroom library, where things belong in the classroom, the equipment that goes into each bin, and other managerial tasks.

Teachers can also reinforce appropriate behavior by snapping photos of students doing things well—as long as the photos capture different students and, eventually, all students. Younger students may need picture reminders of important people in the school, including janitors, playground supervisors, and bus drivers.

Photos also provide visual ways for bilingual children to "see" concepts under study as they are building academic language. For instance, teachers can take photos of a bread slice in stages of decomposition to demonstrate "change over time." Showing the photos illustrates the concept in a memorable way. Develop an eye for photo opportunities that illustrate curricular concepts, and keep your camera handy.

Documentation panels serve as another excellent instructional use for digital cameras. Documentation panels can be made at any grade level by students, as teacher-student collaborations, or by the teacher alone. The purpose of the panels is to illustrate various facets of the students' learning in process. The photos show students as they are engaged in learning activities, including progressive steps of creating artifacts, such as writings, drawings, diagrams, charts, slideshows, videos, and 3D objects.

Photographs and objects are arranged in sequence on a panel, such as a science fair trifold, a bulletin board, or poster board, so viewers can see at a glance how students went about acquiring knowledge related to a learning goal. The learning goal should be stated at the top and the sequence of photos and artifacts numbered. Picture captions and/or quotations from students throughout their learning finish off the panel.

When posted, panels should be self-explanatory. Teachers can use them to communicate to parents, administrators, and visitors how learning happens in the classroom. Students can make documentation panels of how-to sequences or the stages of an experiment. Whatever the topic, documentation panels make the learning process visible.

Increasing visual input in classrooms also refers to using visuals as teaching tools during instruction. For first-grade teacher Diane Vyhnalek, the addition of a document camera to her classroom enhanced her opportunities to use visual materials while she was instructing. Much of what she shared about her document camera use could be used in any classroom for more complex tasks and content.

Classroom instruction often favors auditory learners, but technology tools can increase the presence of visual instructional materials available for instruction. Consider how visuals enhance the following examples of whole-class and small-group instructional targets.

Documentation Panels

Documentation panels show how the process of learning unfolds in school. Although originally used for preschools, documentation panels fit into all classrooms. Teachers or students can create documentation panels on poster boards or bulletin boards to illustrate the learning process. Documenters post digital photos with captions that show the stages or steps of learning and may include student quotes and artifacts, such as drawings or charts.

For instance, at the primary level, observers may think of library visits as fun times for students—listening to the librarian or teacher reading books aloud and checking out their own books—but not as learning experiences. To demonstrate how library visits comprise effective education, librarians can show evidence of student learning by creating a documentation panel.

By documenting the learning that happens during a library visit, the librarian makes the high educational value of a library program public. Parents and visitors can scan the panel quickly and comprehend the types of learning experiences children have.

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Whether documentation panels are created by teachers, librarians, or students, the processes of collecting pictures, quotes, and artifacts, as well as developing short, informative captions, cause the documenter to reflect on what was important and to communicate it to an audience.

Photos of students learning from activities	Captions about what students learn during library activities	Students' quotes about what they learned from library activities
Students listening to a story	While listening to stories, students imagine, make predictions about, and connect to children's literature.	"I liked acting out the story during story time. It was a fun book."
Librarian holding several books during a book talk	Students learn about books and authors new to them.	"I like it when the librarian tells us about new books."
Students at bookshelves	Students learn how to locate fiction and nonfiction books on library shelves.	"I want a book about snakes. That's nonfiction, and I can find it on these shelves."
Student using a shelf marker while looking at a book	Students place a marker on the shelf when they remove a book. If they decide not to check out the book, they'll remember where it goes.	"You have to put a marker to save your place so if you don't want the book, you can put it back."
Student using the five-finger method to choose an appropriate book	Students learn how to tell if a book is just right for them.	"I like chapter books, but some are too hard for me."
Students at a puppet area or a listening station	Students discover other learning possibilities in the library.	"I like borrowing puppets to play at home."
Students at the checkout desk	Students learn to take responsibility for books they borrow and return them on time.	"This hole is where the books go when you return them."
Students sitting and reading	Students read while they wait patiently for their classmates.	"I found my book fast, so I can start reading right away!"

VOICES OF EXPERIENCE

Diane E. Vyhnalek, former first-grade teacher
Lois Lenski Elementary School, Centennial, Colorado

A Day in the Life of a Document Camera in First Grade

I was introduced to using a document camera as an instructional tool in my classroom by Boni Hamilton, then my school technology advisor. Now, the document camera has become my strongest partner for integrating technology and for empowering my students to be responsible for their learning. In order for me to have high expectations for my students' academic growth, as well as teaching them to self-assess, the document camera allows students to have independent practice along with my explicit teaching. Students need to see that we, as educators, do believe in them and their abilities to learn. Allowing them to use the document camera to show their learning allows students to have a voice.

Starting with daily orientation activities, the document camera greets students. I use it to model and clarify directions for seatwork. It serves as a model for demonstrating correct letter formation during handwriting practice and for showing how to write our numbers with the use of instructional poems. It is used for the morning message and calendar time. A daily cartoon from the comics is presented on the document camera. The message is covered, and students use their background knowledge merged with picture inference skills to determine what a possible caption might be. Students are given an opportunity to predict their thinking before seeing the artist's message.

The document camera is used to present lessons for daily phonics lessons. Students use the document camera to create words for their word work. Tile letters may be moved on the camera to show understanding of building words. The document camera helps all students, especially visual learners, to acquire skills and strategies needed to be successful readers.

The document camera is used during the reading block to create story webs, make chapter frames, build discussion webs together, and allow applications of different strategies needed for success in the genre studies. It allows for visually teaching the features of an informational text, so the students may then write their own informational texts on topics of their choice.

Continued

During the writing block, students are encouraged to work together to create story elements and participate in class editing of sample paragraphs. Students are invited to share their writing samples on the document camera, as well as present orally from their daily journals.

The document camera is connected to the projector through my computer. This connection allows for a scaffolding of activities that were not available before document cameras. It also allows us to access the computer lab via our school server, where students have their folders. In this way, students' folders are available for our classroom use, and parents are allowed access to their children's folders for conferences. Students often give their own PowerPoint presentations in our classroom, present research on science topics, and share poetry and other creative writing projects. In addition, this toggle connection allows me to share enrichment videos for all subject areas from our Discovery Education account.

The math instructional time becomes engaging with the document camera, as students model their thinking, demonstrate steps to solve problems, and use a variety of math manipulatives, such as discs, coins, rulers, and geometric shapes. When we discuss measuring the weather, the computer may be toggled with the document camera to share the current temperature, wind velocity, and forecast.

Social studies and science units are highlighted with the use of a document camera. In social studies, students share their self-authored books about family traditions, and as a class we look at the features of maps. Some of our favorite activities involve the class in talking and thinking about science. Science experiments and other science units of study are enhanced when the document camera zooms in to show exact body details of insects or pictorial captions and diagrams in nonfiction texts. Of course, the computer allows access to websites about animals, which can be projected for classroom discussions and brought up on students' individual computers.

The art teacher instructs weekly in our classroom, so she frequently uses the document camera for her instruction. The camera might be used to model the shapes students are using for their five-minute sketches or as a tool to model the steps needed for a particular art lesson. An art show is created when students share their work on the document camera.

As you can see, the possibilities of using the document camera in primary classrooms are limitless, as we educators become informed about this and the many other uses of technology to support our teaching.

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Develop Background Knowledge

The use of pictures can make content come alive for students who lack background knowledge about a subject. For example, to introduce a novel set in Venice, one teacher used Google Earth and online photographs. Students were then better able to comprehend the novel's context because they could visualize it. A first-grade teacher toggled among an actual dragonfly carcass on the document camera, a website with photos of dragonflies, and a video clip to introduce a unit on insects. Science teachers can access a wealth of visual materials about the natural world through **Arkive** (arkive.org), including photographs and videos of wild animals. By incorporating web resources and real objects to introduce units, teachers can give all students simultaneous visual, auditory, and tactile experiences before units begin.

Model an Activity or Skill

Students have more success with new processes when teachers model the skills. Diane Vyhnalek not only modeled how to write the month on lined paper, but also invited students to compare their writing to hers. Because she used the same paper as they did, students could set their work next to the teacher's for comparison. Interactive writing, problem-solving strategies, graphing, steps of a science experiment, and "reading" a historical photograph are all more easily understood if students can see visual modeling.

Read

While it's common for primary teachers to show students books as they read aloud, teachers at other grade levels should consider how adding visual components could supplement students' comprehension of texts. The visuals might be the illustrations from a text being read aloud, but it also could be showing students the conventions of nonfiction texts, reading story problems to identify critical information, or analyzing graphic images or complex mathematical equations. Test-taking skills are more memorable when students can read sample instructions or test questions to analyze what they are expected to do. By using a site like **Docs Teach** (docsteach.org), secondary social studies teachers can help students learn to read and annotate historical documents. Tapping into videos as visuals can hook students into language arts or content area texts.

Demonstrate

Science teachers, in particular, despair of having every child see a demonstration of a lab procedure when students crowd around their teachers. When document cameras are used, students stay seated, and the teacher projects the steps of the experiment for all to see. One teacher conducted the experiment in advance of class, captured each step with the document camera's photography interface, and placed the photos in a slideshow. During the experiment, student teams completed each step simultaneously, and the teacher projected the slides to demonstrate what they should see. Equipped with a wireless mouse and a laser pointer, the teacher circulated among the teams, advanced the slides, and used the laser to highlight particular sections of photographs.

Solve a Problem

Although we may think of problems primarily in terms of math, consider the variety of problems students may encounter during school days. A counselor showed students video clips and photographs of conflicts at school, then invited the students to discuss how they could solve the problems. A writing teacher showed the class a student's well-written paper and asked the students to suggest where the writer could expand the text with additional examples. Classmates came up with three places where the writer could add text.

Explore

Numerous websites lend themselves to whole-group exploration, discovery, and engagement: Consider a series of video clips from NASA; a preliminary visit to a virtual manipulatives site, such as nlvm.usu.edu/en/nav/vlibrary.html; or a literacy site with good content written at a higher reading level than the students can manage, for example, magickeys.com/books. A third-grade teacher combined an exploration of the **Scholastic Interactive Tour of Ellis Island** site (teacher.scholastic.com/activities/immigration/tour) with a series of primary-source photographs of immigrant families to trigger rich conversations about what students noticed. Placing a 3D object on a document camera allows simultaneous examination of its details. For instance, one teacher placed a series of rocks and gems on the document camera and asked students to identify and classify them.

Review Information

Some teachers like to download or create games for whole-class reviews of content, especially before a test or to teach test-taking skills. Students can also create their own electronic K-W-L (What I Know, What I Wonder, and What I Learned) charts and revisit them every week or so to update their accomplishments. In one middle-school classroom, the teacher periodically displays the pretest questions and asks students to answer them; this shows them how much they have learned and encourages them to continue learning. A group of teachers displays student-created slideshows to review vocabulary words. Some teachers use **Kahoot!** (kahoot.com/welcomeback), an online interactive quiz platform, as a formative assessment tool. In Kahoot, although students type in aliases to identify themselves publicly, the teacher can see their real names and their answers.

Respond to or Critique an Idea or Sample

Having trouble getting students to work toward excellence in their projects? Show an example from an earlier year or one you've made, and have students create a rubric based on their critique of the sample. Writing lessons lend themselves to critique; with a student's permission, teachers can show a sample and ask the class to discuss the strengths of the work along with ideas for improvement.

Engage Students in Thinking about and Discussing Ideas

As a warm-up for teaching thinking skills, a teacher showed one-panel comics and asked students to think about what was happening to the characters in the comic, as well as outside the comic—that is, what actions might have occurred before and what actions could occur later, as a result of the comic situation. Comics can teach inference, vocabulary, punctuation conventions, visual literacy, and sometimes even cultural references.

Another teacher often used provocative editorials for students to analyze. They considered where and why the arguments were strong, misleading, or misinformed. The goal was critical thinking about persuasive writing, and students loved the activity.

Concept cartoons are excellent ways to generate conversations and tease out possible misconceptions. In a concept cartoon, characters make statements about a concept, one that the teacher is introducing or one that the students are studying.

Each character takes a different point of view, with several characters stating misconceptions that students may have. Students think about the statements and align themselves with one viewpoint. Through discussion, students eliminate incorrect or illogical ideas to identify the correct concept.

A variation of the concept cartoon would show characters making statements representing various points of view about a topic on which students have different opinions. For instance, the comic characters could disagree about a decision made by a character in a book they have studied, or the disagreement could be a debate on the best location for NASA's next exploration. This type of dialogue helps students learn about and understand valid points of view that may differ from their own.

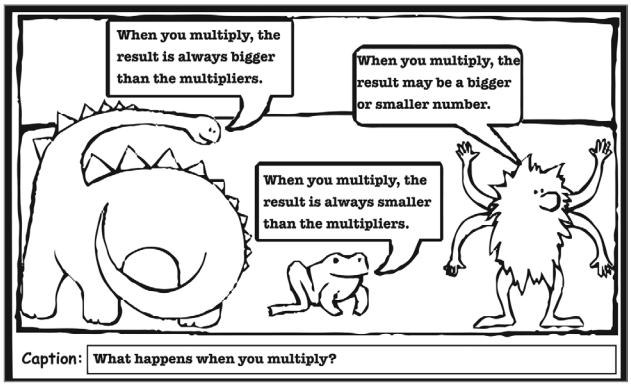

Figure 5.5. Concept cartoon created by Boni Hamilton in Comic Creator at ReadWriteThink (readwritethink.org/files/resources/interactives/comic).

Reach beyond School Walls

If you want students to be excited about learning, use the internet to connect with someone in another location, even a classroom down the hall. The potential for teleconferencing boggles the mind. Students can talk to experts, students in other classrooms, and individuals who are exploring unusual places or creating fascinating objects. In one school, students kept in contact with a young man as he hiked across several countries. One teacher used Skype as a classroom management reward: When students earned enough good behavior points, they called the teacher's mother and met the teacher's dogs.

The use of technology tools for visual learners balances the auditory/verbal activities that normally predominate in the classroom environment. When teachers increase the visual stimuli they allow students to use in the classroom, they notice an increase in student engagement, particularly for students who struggle to complete text-based tasks. In addition, all students, no matter what their learning preferences, benefit from projects and ideas that encourage the use of visual skills.

Presentation Slideshows as Instructional Material

After teaching preservice teachers for the past few years, I've become aware of how much presentation slideshows, such as PowerPoint, have saturated the education world. Almost every preservice teacher considered slideshows the best way to teach with technology. Unfortunately, typical bulleted slideshows replicate a lecturer writing notes on the board—a great way to lull your students to sleep. If you would like to use slideshows as effective instructional tools in your classroom, consider the following guidelines.

Use photos, not bulleted notes or clip art. In visual presentations, bulleted notes signal that students do not have to listen or participate, just copy. A good photo will trigger emotion in the viewer. Students' responses open doors for conversations about what is and is not in pictures. When students learn to read pictures or illustrations, they strengthen their inference, critical thinking, and visual literacy skills. By identifying details of objects, individuals, and environments, they learn to draw inferences. In addition, they retain what they see longer than what they hear, and become more conscious of how visuals contribute to understanding ideas.

Want to spark students' motivation to acquire background knowledge? Project relevant pictures and let students infer what the pictures mean. Want to provoke deeper thinking? Show pictures of student work and have students analyze them. Teaching internet safety and responsible use? Capture screenshots of online forms or webpages for students to discuss as safe or unsafe. Cartoons and humor can make new information memorable as well. A concept cartoon can capture any controversial or many-sided topic on which students may have differing opinions or understandings. Clip art, categorized by one astute student as "the lowest bid art," looks like a decoration and rarely elicits an emotional response other than derision.

Continued

Stop talking. Each time a new slide appears, presenters need to give the audience at least 30 seconds to scan the visual and think about the new idea. Then, if explanations are needed, ask questions: What do you notice? How does this relate to what we are studying? Let students construct shared knowledge. Encourage them to disagree, question, press a viewpoint, and be willing to change their thinking. Even if the slideshow is a demonstration of an experiment, students will learn more if they construct an explanation based on the picture than if the teacher tells them what they should notice.

Skip the animations and transitions. Animations and transitions in slideshows expose presenters as beginners. Such tricks either annoy or distract audiences. The goal is to convey meaning, not entertain.

Be clear about the message. When the slideshows end, audiences (students) should have a clear understanding of why teachers created the shows. Creating a show should not take more time than learning from it. Use slideshows to provoke student discussions. They learn more from listening and reacting to one another than from hearing a teacher's interpretations. If you must put words on a slide, write the takeaway message of that slide as a sentence instead of a title. For example, instead of "Branches of Government," write "Three branches of government provide a system of checks and balances."

Fifteen Fabulous Visual Projects

1. Drawings. Draw a visual representation of a vocabulary term or a scene from a book.
2. Show What You Know. Draw and label a content concept such as a life cycle or a chemical element.
3. Build an Avatar. Design a portrait for an online profile.
4. Graphic Organizer. Create a visual organizer from scratch.
5. Event Timeline. Sequence an event with pictures and captions.
6. Illustration. Illustrate a writing project or a complex procedure.
7. Sequence Slideshow. Picture the steps to a sequence in a slideshow.
8. Visual Dictionary. Illustrate idioms or social studies terms.
9. Cartoon. Develop a cartoon with a political message or as a public service announcement.
10. Map a Route. Trace the westward movement or the settlement of your state.
11. Graph It. Collect and display data.
12. Document. Build a documentation panel about safe online searching or research processes.
13. Augment. Use augmented reality to enhance a report.
14. Historical Dialog. Import historical photos and add dialog boxes.
15. Book It. Create a wordless picture book from self-produced photos.