Chapter 7

Web-Based Communication, Collaboration, Design, Creation, and Making

Learning Outcomes

After reading this chapter and completing the learning activities, you should be able to:

7.1 Identify the features and uses of various web-based communication resources. (ISTE Standards for Educators: 1—Learner; 4—Collaborator; 5—Designer; 6—Facilitator)

7.2 Select collaborative web-based resources and strategies that would be most effective for teaching and learning. (ISTE Standards for Educators: 1—Learner; 2—Leader; 3—Citizen; 4—Collaborator; 5—Designer; 6—Facilitator)

7.3 Describe web authoring tools, web design perspectives, and web development processes required for web page or website creation. (ISTE Standards for Educators: 5—Designer; 6—Facilitator)

7.4 Explain how learners engage in a design process when they create and make activities with web-based computational technologies. (ISTE Standards for Educators: 1—Learner; 2—Leader; 5—Designer; 6—Facilitator)

Technology Integration In Action: Flipping for Statistics Mastery

GRADE LEVEL: High school

CONTENT AREA/TOPIC: Statistics and Probability

LENGTH OF TIME: Four days

(*Continued*)

PHASE 1 Analysis of Learning and Teaching Assets and Needs

Step 1: Analyze problems of practice (POPs)

Mr. Patel knew that he needed a better approach to teaching course content in his statistics and probability course. When the state started requiring 4 years of mathematics, he offered to teach this course. But passing rates for the end-of-course tests were low, and an analysis of students' test performance showed that their difficulty with skills began with the introduction of data measurement, specifically, the measures of central tendency: mean, median, and mode.

Step 2: Assess technological resources of students, families, teachers, and the school

Mr. Patel had just polled students to identify their technological access at home, and he was surprised that only 3 of his class of 30 students lacked broadband Internet connectivity at home. Mr. Patel had expected more students to raise their hands because some families lived in more rural areas that he suspected might not have high-speed options. Interestingly, all students either had access to video game systems or had played video games with their friends, and all had used social networking sites at least occasionally. As a teacher, Mr. Patel's pedagogy mainly used direct instruction, including lecture, problem worksheets, quizzes, and tests. He had a classroom website where he posted his lecture notes and **slide decks**. The school had recently been awarded a grant geared toward technology integration in mathematics, so the school's technology specialist, Ms. Anand, was poised to work with many of the teachers.

Step 3: Identify technological possibilities

Mr. Patel and Ms. Anand met after school to discuss ways in which he might tackle his problem of practice, the low student achievement in his course. His current pedagogy and use of a website didn't seem to be meeting all the students' learning needs adequately. Mr. Patel remembered hearing about flipped classroom methods in a recent professional development meeting and suggested that he might record his lectures for previewing so that students could spend more time applying the concepts during class time. Ms. Anand liked the idea but offered another idea, to integrate Lego Mindstorms as an application activity in class. She had just read about a lesson using it to learn means, modes, and medians, and she was willing to purchase the technology from grant funds. Mr. Patel was excited but also apprehensive about his own technological knowledge. Yet he wondered if these technologies and new pedagogical approaches might turn around his students. Ms. Anand volunteered to team-teach the Lego activity and fully support the video development. When Mr. Patel told his principal about his flipped pedagogy idea, she arranged for him to check out three tablets on which he could preload the video content for the three students without home Internet access.

PHASE 2 Design of the Integration Framework

Step 4: Decide on learning objectives and assessments

Mr. Patel had some specific outcomes in mind to measure the success of this new venture and to decide whether it was worth expanding to other units. He wanted to make sure that students were actually watching the videos at home before class. He wanted to determine whether their knowledge of the mathematical concepts was improving based on watching the videos and/or based on the Lego activity and whether they liked the new strategy better than the old way. The outcomes, objectives, and assessments he decided on were as follows.

Outcome—Watch required videos and complete conceptual questions prior to class.

- **Objective**—All students will indicate that they have watched videos.
- **Assessment**—Graded items on conceptual questions will provide a sense of post-video understanding.

Outcome—Engage in Lego activity and complete conceptual questions.

- **Objective**—All students will participate in activity.
- **Assessment**—Graded items on conceptual questions will provide sense of post-video understanding.

Outcome—Demonstrate mastery on unit quiz.

- **Objective**—At least 90% of all students will achieve a passing score (85% or more) on the unit quiz.
- **Assessment**—Graded quizzes.

Outcome—Determine attitudes toward flipped classroom tasks and outcomes.

- **Objective**—The students will communicate their attitude toward the flipped approach with at least 90% of students completing the attitude survey.
- **Assessment**—Likert scale attitude survey.

Step 5: Design integration strategies and determine relative advantage

After reviewing how he is currently teaching the data measurement unit, Mr. Patel decides that students can watch one video and complete preclass conceptual questions about it after which the class would do the Lego activity. The project would have the following timeframe:

Day 1: Provide an overview. On Monday, Mr. Patel introduces the topic of data measurement and provides examples of its applicability in life. For homework, he assigns students to watch a video and complete conceptual questions about the mean, media, and mode. Mr. Patel inserts the video into Google Forms, and students watch the video, complete the form as an exercise, and submit the form to him online before Tuesday's class.

Days 2 and 3: On Tuesday and Wednesday, Mr. Patel and Ms. Anand set up a Lego Mindstorms experimental apparatus for students to collect data. On Wednesday, students analyze the data in Google Sheets.

Day 4: Students take an in-class unit quiz covering all the material. Then the class reviews the answers and students complete the attitude questionnaire in Google Forms.

Relative Advantage

Regarding the flipped approach, Mr. Patel determined the relative advantage by RATifing the new unit. Figure 7.1 shows the aspects of instruction, student learning, and curriculum that he felt would be impacted by having students access a prerecorded video lecture and then engaging in the Lego activity. He recognized that the video lecture, on its own, seemed replicative but had potential amplified impact on student learning. He could see the transformative potential of the Lego activity. He felt there was relative advantage to the flipped unit.

Step 6: Prepare instructional environment and implement lesson

There was much to do before beginning the actual flipped unit. Preparation tasks included:

- **Video development**—Mr. Patel carefully considered the content on data measurement that he wanted his students to master. He wrote a script for what he would cover before beginning actual videotaping and created slides. With Ms. Anand's help, they decided to create the video using the ExplainEverything app.
- **Lego activity**—Ms. Anand and Mr. Patel used Lego Mindstorms NXT to design an experiment to collect measurement data using a Lego ultrasonic sensor that measures distance. The sensor is placed on a clamp-stand from which a spring-mass system (a 1 kg mass) hangs on a rubber band with an attached cardboard platform. The Lego Mindstorms software records the change in distance as the platform oscillates, and students can export the software data and import it into Google Sheets for analysis to determine the mean, mode, and median and discuss outliers.
- **Conceptual questions, quiz, and survey development**—Mr. Patel then created the post-video and post-Lego conceptual questions, the unit quiz, and the attitude survey.

PHASE 3 Post-Instruction Analysis and Revisions

Step 7: Analyze lesson results and impact

After the unit, Mr. Patel reviewed the results. All students but two had watched the videos, and 50% of students demonstrated conceptual understanding of measures of central tendency—mean, median, and mode—but after the Lego

Figure 7.1 Mr. Patel's RATified Lesson

	Instruction	Learning	Curriculum
Replacement Technology is different means to the same end.	• Teacher lecture via video		
Amplification Technology increases or intensifies efficiency, productivity, access, capabilities, etc., but the tasks stay fundamentally the same.		• Students can watch and rewatch video lecture	
Transformation Technology redefines, restructures, reorganizes, changes, and creates novel solutions.	• Lego Mindstorms shifts teacher from lecturer to co-researcher	• Students construct and analyze data with Lego Mindstorms to apply & understand math concepts	• Lego Mindstorms offers a scientific experiment connection to mathematics

(Continued)

activity, 98% of students demonstrated conceptual understanding. In terms of students' attitude, they wanted more of this flipped pedagogy, and they appreciated the Lego activity because they were able to apply mathematics to an actual physical context.

Step 8: Make revisions based on results

Creating the instructional video took a long time. Mr. Patel felt that if he were going to use more flipped pedagogy with video, he might need to research other resources, such as open educational resource (**OER**) options. He hoped that Ms. Anand might be able to assist in finding such resources.

Step 9: Share lessons, revisions, and outcomes with other peer teachers

After completing the project, Mr. Patel learned of a Flipped Learning Network, @flippedlearning on Twitter, and followed it. He tweeted his lesson out to the **hashtag** #flippedlearning and #edtech and received some ideas for OER video resources. He told his principal about the results and planned to do a demonstration for an upcoming teacher professional development day in his district.

Based on concepts from "Ms. Garcia's Flipped Pre-algebra Class" on FLN; George Phillip's blog "Reversing Instruction in Social Studies"; and Williams, K., Igel, I., Poveda, R., Kapila, V., & Iskander, M. (2012). Enriching K-12 science and mathematics education using LEGOS. *Advances in Engineering Education*, *3*(2), 1–27.

Introduction

Today's students are first-generation citizens of a digital society, pioneers in a land that has no borders and whose contours took shape only in the last decades. In this chapter, we delve more deeply to understand web-based resources that support teaching and learning activities that involve communication, collaboration, design, creation, and making. Communication options range from email to texting to videoconferencing: ways to get your messages across. But it is collaboration resources like blogs, twitter, wikis, and social networking sites that make the global local and the local global. Finally, website development, multimodal web creation, and computer programming make teachers and learners into the designers and builders of this borderless land as well travelers within it. This chapter provides the final foundations for **blended** and **online learning** strategies that you will learn about in Chapter 8.

Online Communications

Online communications have nearly replaced traditional channels such as sending letters and making telephone calls. The tools described in this section are considered primarily for one-to-one communications rather than social collaboration and networking among groups, which is the topic of the next section. However, the line between the two is becoming increasingly blurry. Communications options are available in both **synchronous** (intended to be seen immediately) and **asynchronous** (left for people to read later) formats. Emails and listservs are considered asynchronous whereas text, instant messaging, and videoconferencing are usually considered synchronous.

Email and Listservs

Email is a common way to exchange written messages between individuals or small groups. Email may be sent via a software program (e.g., Microsoft Outlook, Apple Mail) or through cloud-based software (e.g., Gmail). Both approaches interface with the Internet for message delivery. Smartphone and tablet apps allow access to email accounts. Teachers have used email to improve communications among students, teachers, and parents, but teachers now tend to use official communication systems built into district-sponsored systems, such as a **student information system (SIS)** or a **learning management system (LMS)**, such as Schoology, Edmodo, Moodle, Blackboard, and Canvas. Because email use among students and parents is rapidly being replaced by

other forms of communication, such as the messaging systems discussed in the next section, SIS and LMS allow for communications to be sent in multiple ways simultaneously, such as by email, web placement, and text alerts. We recommend that teachers have a separate personal email address they use for friends and family and a professional email account, preferably the district-sponsored email account, for communications with teachers, parents, students, and the community. Consider everything you write in district-sponsored email to be publicly available information.

Listservs are programs that store and maintain mailing lists of emails and make possible ongoing email "conversations" among groups who belong to an organization or share common interests. When an e-mail message is addressed to a listserv mailing list (one email address), it is automatically duplicated and sent to everyone who is a member of the list. Replies to a listserv also go to list members, and only those on the list can send a message to a listserv.

Instant Messaging and Text Messaging

Instant messaging (IM) and **text messaging (texting)** are two services that allow users to see messages immediately. IM is an online exchange of messages between people conducted through (1) an Internet application, such as Apple iChat and Yahoo Messenger, (2) a mobile phone application, such as WhatsApp and Kik, (3) social networking applications, such as FaceBook, and (4) online games. IMs are exchanged instantaneously, but they also may be left as messages to be read later, and the person notified can then initiate a chat session. Text messaging allows for asynchronous exchange of text, image, or video communications between people on mobile phones. There are also messaging apps that autodelete, such as Snapchat and Wickr, or allow anonymous posting, such as YikYak and Whisper. Text messaging has become such a primary means of communication that it has overtaken voice communications on mobile phones in frequency of use.

The two kinds of communications share some common features and uses. For example, users make frequent use of **textese/textisms**, such as RUOK for "Are you okay?" and CUL for "See you later." Many educators worry that textisms could negatively impact students' oral or written literacy. Verheijen (2013) examined 19 studies on the effects of text messaging and instant messaging on literacy. The majority of studies discovered positive correlations between texting/IM and literacy; however, the studies overall are quite mixed with some showing negative correlations with literacy or conflicting results. Research by van Dijk et al. (2016) with children ages 10–13 suggests that texting is a separate register that is context sensitive, and thus, might not negatively impact the academic written register. However, they did find a correlation between dropped words in texts and increased grammar proficiency, indicating that crafting shortened texts strengthened students' grammar. Texting/IM is becoming a common practice for synchronous communications and is built into many other web-based resources, such as LMSs, and the mixed research results might suggest that the use of textisms is not negatively harming students' academic literacy.

Videoconferencing for Synchronous Communication

Videoconferencing is multiway interactive communication allowing those involved to see and hear each other. Presenters and participants need a **webcam,** an audio input device such as a microphone, and an output device such as speakers or headphones. At a minimum, viewers need earphones. In addition, each participant must use a program such as Skype, FaceTime, and Google Hangout or a web browser feature that enables video communications. It is also helpful to have a high-speed connection so the video will move smoothly. Videoconferencing is becoming more common when high-speed Internet is available in schools (Raths, 2015). In Chapter 6, we described how videoconferencing contributes to the development of live web-based content that can be archived. It also facilitates synchronous communicative interactions between students

Video Example 7.1 Videoconferencing between Two Classrooms

In this video, you'll see the videoconference between Hawaiian and New Hampshire students in which they exchange knowledge on historical and cultural topics related to their cultures and geographic areas.

and others. For example, videoconferencing is often used in the context of language learning programs in which hearing the spoken language is an essential component of instruction (Perez-Hernandez, 2014). Hopper (2014) described using videoconferencing to complete cross-cultural, project-based learning activities with students in Japan, Belarus, and Kenya.

Online Communication Integration Strategies

Communication technologies can facilitate interpersonal exchanges in which students communicate with other students, teachers, or experts. Some example activities include:

- **Pen pal writing exchanges**—Teachers link each student with a partner or pen pal in a distant location to whom the student writes letters or diary-type entries. Teachers can find partners at the ePals and OneWorld Classrooms websites.
- **Mentoring**—Students can link with mentors in the form of other students, parents, or individual experts in a given field. For example, teachers put students in touch with scientists who volunteer to answer questions about their areas of research and recent findings. Mentored Pathways is a source for finding mentors.
- **Field trips**—The Denver Museum of Nature & Science hosts a virtual science academy in which classes using interactive videoconferencing can explore and learn from museum assets without physically visiting.
- **Classrooms without walls**—Teachers are expanding curriculum activities to involve other communities across the globe. Raths (2015) describes teachers in Alaska who began videoconferencing their classrooms and expanded to larger collaborative activities that involve classrooms in Afghanistan, Israel, Yemen, Palestine, and Ghana.
- **Access to courses**—Videoconferencing as part of a fully online course allows students, such as those in small or remote districts and who are unable to attend school, access online courses, such as German (Raths, 2015).
- **Parent-teacher conferencing**—In the busy lives of parents, options to videoconference can increase communication and sharing between parents and teachers (VCDaily, 2016).

Check Your Understanding 7.1

Online Collaboration

Online spaces that allow people in any geographic location to come together for the purpose of sharing and creating content are broadly referred to as **social networking sites (SNSs)**. SNSs are also referred to as **web 2.0** resources because they changed online activity from users viewing experts' content (i.e., **web 1.0**) to participating in interactions that create user-generated content. These resources, which include blogs, microblogs, content curation, wikis, video- and photo-sharing communities, and SNS, allow not only faster widespread adoption than most previous technologies but also have had unprecedented impact on society and civilization. Web 2.0 resources bring together communities from around the world whose members can be diverse in nearly every way except for a shared interest in a topic or activity, and they have enabled endeavors ranging from funding research to supporting revolutions. Education, too, has experienced a revolutionary impact from these collaborative web-based resources. This next section focuses on the most powerful educational uses and integration strategies.

Blogs

A **blog** is a type of web page that began as personal journals, but their use rapidly expanded to become sites where a blogger posts content and where others can post responses to the content. A **vlog**, a combination of *video* and *blog*, is a video version of the blog in which posts are video clips instead of text entries and is described later in the chapter with audio and visual creation activities. Blogs are created, designed, managed, and updated by an individual with regular entries of event descriptions, opinions, narratives, and commentaries added over time. Blog authors can upload images, video, links, and other documents to support their content. Users do not have to understand **hypertext markup language (HTML)** or other web authoring languages to create and update blogs; rather, most blogging sites, such as WordPress and Blogger, provide a system that consists of easy-to-use forms in which users enter their text, images, and content and publish content online immediately or at a scheduled time.

BLOG INTEGRATION STRATEGIES Blogs have supported a variety of productivity, instructional, and administrative purposes. Some of these are:

- **Support for engaged writing**—The most high-profile use of blogs has been to encourage more frequent, engaged writing among students in content areas. These activities emerged soon after blogs became widely available and have been ongoing for over a decade. Vurdien (2013) reported on one of these strategies in advanced-level English language learning courses in which students kept personal blogs to read and comment on each other's work. They were encouraged to use their peers' comments to edit and improve their writing. Freeman, Higgins, and Horney (2016) found the use of a blog for elementary school–age students beneficial for mathematical sense making as long as notes and content were assessed. They also found that these students used pictures for sense making, so inclusion of multimodal writing was important. Petko, Egger, and Graber (2014) found no significant difference between secondary science students' learning gains when comparing blog and paper-and-pencil reflective journaling with prompts. However, without prompts, the paper-and-pencil group's learning exceeded those of the blog group. Collectively, using scaffolds such as prompts and assessment feedback is important.

- **Collaboration in content area topics**—Blog activities have been reported in a wide range of content areas to improve collaboration skills in ways that enhance content learning. For example, Paroussi (2014) reports on a cross-classroom blog collaboration in which students engaged in writing tasks and shared them on a common blog. Students felt that the real audience increased motivation to write; they learned to be critical readers examining meaning over form; teachers observed all students showing improvement. Hossain and Wiest (2013) used blogs in a middle school geometry classroom to increase students' collaboration on mathematics problems. Still other teachers have their students follow blogs of professionals in various areas, analyzing their content and even posting comments, thus becoming a part of a professional community while still in school. See Technology Integration Example 7.1 for an example of students collaborating to produce a blog about their community-based geographic and historical research.
- **Communication among teacher communities of practice**—Teachers also get involved in blogs as a professional development strategy, from generating ideas for lesson plans to gaining new skills in their content area. By following others who teach their grade level, topic, or population, teachers become part of a thriving **community of practice** that helps them reflect on and develop skills and solve problems with the help of knowledgeable peers.
- **Increased interaction with parents and community members**—Some schools keep blogs for certain areas, such as the school library/media center, to communicate with stakeholders. The schools post notices of events and hold discussions about how to get funding, solve problems, and make the best use of school resources. These uses keep open lines of communications and forge working partnerships between school and community.
- **Updates and insights on education topics**—Educators of all kinds, including school administrators, follow blogs for the same reasons that they read education newsletters, columns, and professional journals. They get insights and timely updates on topics ranging from education issues to free resources for technology integration. Some significant blogs that educators can follow include MindShift (KQED), Edudemic, The Innovative Educator, EduTopia, and EdTech RoundUp.

Technology Integration

Example 7.1

TITLE: Comparing Local Histories

CONTENT AREA/TOPIC: Social studies, history

GRADE LEVELS: Middle school

ISTE STANDARDS•S: Standard 3—Knowledge Constructor; Standard 6—Creative Communicator; Standard 7—Global Collaborator

NCSS THEMES:1 – Culture and Cultural Diversity, 3 – People, Places, and Environments, 4 – Individual Development and Identity, 5 – Individuals, Groups, and Institutions, 9 – Global Connections; Disciplinary Standards: 1 – History, 2 – Geography, 3 – Civics and Government, 4 – Economics

DESCRIPTION: After researching the geography and history of their own town or community, students use web 2.0 tools to share their findings with their peers in other countries. Students practice numerous research skills, such as interviewing and document analysis, while acquiring an understanding of how the history of the region they studied is connected to their lives. They work in small groups to produce a blog website to compare and discuss their communities.

Source: Based on ideas from the Local History Project lesson at the iEARN website.

Microblogs

A **microblog** is a social technology that allows users to express micromessages (i.e., a 140-280 character **tweet** on Twitter, photos on Instagram, and messages on Tumblr) that can include web links, hashtags, video (e.g., YouTube and Vimeo), pictures, and photos. On these sites, users can create an identity, follow other users, and determine privacy settings. On Twitter, hashtags allow others to identify topics and create their own messages on the same topic. For example, those interested in educational technology can use the hashtag #edtech to find posts related to that topic. An increasing number of young people are using microblogs. Lenhart (2015) found that 33% of teens use Twitter, 41% used Snapchat, and 51% use Instagram. Wang (2017) found that large school districts and some superintendents were using Twitter but mostly for one-way broadcasting type announcements, and Wang encouraged more conversational, two-way communication activities.

MICROBLOG INTEGRATION STRATEGIES Consider the following integration strategies that teachers and researchers have developed for K–12 students:

- **Sharing classroom learning**—Both teachers and students can share learning moments with a class hashtag. For example, Katie, an elementary school teacher, mentored her students to share the "what" and "why" of their learning (Marich, 2016).
- **Formative assessment**—Teachers can have students tweet answers (along with a specific hashtag) to occasional content-related questions to gauge understanding (Taylor & Weigel, 2016). The archive of the hashtag allows the teacher to examine responses in more detail at a later time.
- **Bulletin boards**—Teachers can make quick, important announcements by setting up hashtags that students and parents can check for late-breaking news or reminders. Van Vooren and Bess (2013) found a significant positive correlation between a teacher's after-school tweet reminders of homework and tests with middle school students' academic achievement in science class.
- **Twitter walls**—This use requires users to download an app that makes a visual display of Tweets on a given topic or by Twitter accounts that the user follows. This "wall display of tweets" supports analysis of comments on a given topic, promotes discussion, and helps learners see the applicability of what they are learning in everyday life (Basu, 2013; Marich, 2016; Rosenbloom, 2012).
- **Support for role playing**—Basu (2013) described educators live-tweeting as famous historical figures, and anyone can follow their "events." For example, the Massachusetts Historical Society live-tweeted the life of John Quincy Adams. This makes history come alive for students and encourages discussion. A high school teacher had his students blog and tweet as Enlightenment philosophers, and students reported going beyond memorization by engaging with questions from a global audience (Krutka & Milton, 2013).
- **Resource collections**—Tweets by students on topics of study to a specific hashtag can be collected into a news stream for everyone to access and use (Taylor & Weigel, 2016).
- **Mentor and experts**—Students can connect with professionals in an area of study, follow their postings, and interact with them to get inspiration and tips on careers (Basu, 2013). #SciStuChat is a monthly chat between high school students and science professionals.
- **Professional learning**— As described in Chapter 3, teachers are becoming teacher leaders through connected learning opportunities supported by many of the web 2.0 technologies. Teachers can connect with other teachers using their Twitter handles or following interest-driven hashtags, such as #Kinderchat and #STEAM.

In one elementary school teacher's journey in learning how to microblog, she was sensitive about creating a classroom Twitter account that uses only first names of her students, to avoid tagging anyone in pictures, and to selectively follow other classroom or educational accounts (Marich, 2016). For older students who can create their own accounts, Taylor and Weigel (2016) advise teachers to show their own professional account as a model for students, have students use an abbreviated form of their name for their handle, limit biographical information with no personally identifiable information, know how to block other accounts, and practice conventions for replying to others. They also suggest establishing rules, including three useful ground rules:

1. Keep communication professional and positive, and all school rules still apply.
2. Do not click on links sent by users unknown to you.
3. Immediately block a user who bothers you and report this to the teacher.

Content Curation

Social bookmarking, curation, and **aggregator** tools allow teachers and learners to collect and organize Internet-based information from various sources into a personal account. Each user creates an online, networked identity and stipulates privacy settings. Most curation resources offer collaboration features in which groups of people can contribute or subscribe to others' repositories or curated information. All these content curation tools allow for collecting information, but curation activities necessitate that users critically analyze the information to create coherent topical or thematic collections, much like a museum curator. With some guidance by the user, aggregators, such as Paper.li and FlipBoard, collect web-based information in one reading area. Users can do the following activities with popular curation, bookmarking, and aggregation tools:

- **Pinterest**—Collect (i.e., pins) visual images and organize such pins on pinboard.
- **Learnist**—Organize text, images, sounds, and video on boards; view other boards curated by topical experts.
- **Storify**—Curate web content, organizes it in a story editor to craft your story, and share it on the web.
- **Pocket**—Save web resources from any device to read or review later.
- **Pearltrees**—Organize, explore, and share interest-based web content.
- **Diigo**—Socially catalog and collaborate by adding links, screenshots, and pages; highlighting or adding sticky notes; and tagging information.
- **FlipBoard**—Aggregate digital content into a magazine-type product.
- **SymbalooEDU**—Visually organize web resources and sequence it into lessons.

CURATION INTEGRATION STRATEGIES Curation provides a range of integration options for teachers and learners, including the following:

- **Content collections**—Teachers of all content areas can curate content-specific materials, including yearbook or photography resources (Taylor, 2014), mathematics lessons or related resources (Hu & Torphy, 2016; Pinterest pages, 2016; Rosenbloom, 2012), and ideas for maker activities (Scheer, 2017).
- **Photo curation**—Parenti (2016) describes the use of curating digital images as comprehension support for struggling readers as they read narrative and informational texts. Through a modeled self-monitoring process, students find images specific to the text type and reading task focus (e.g., character, plot, setting in narrative or people/inventions in informational texts) that will aid the learners' comprehension that is assessed through a retelling activity. Rosenbloom (2012) describes curating photos of the world in Pinterest to then share them with her students to inspire mathematical inquiries and develop a mathematical lens for examining the world.

- **Student research**—Students collect and curate web resources as an additional aspect of informational research processes, such as background information, or to collect inspiration for art or photography projects.
- **Lesson resource planning**—Teachers can use tools such as LessonPaths, BlendSpace, and Symbaloo to curate learning resources for web-supported, digital lessons. These are helpful for flipped or independent learning pedagogies.

Wikis

A **wiki** is a collection of web pages that encourages collaboration and communication of ideas by having users contribute or modify content. Wikipedia is the most well-known wiki with a mission to produce a free encyclopedia that is created, constantly updated, and self-monitored by its users. Students often use Wikipedia for its convenience but realize its inherent credibility issues (Blikstad-Balas, 2016), and teachers and librarians understand the need for explicit instruction regarding the use of Wikipedia as an informational resource (Polk, Johnston, & Evers, 2015). Beyond the use of Wikipedia, teachers can establish wikis in K–12 settings using the following tools:

- **Wikispaces**—Free Wikispaces Classroom is available for individual teachers to create wikis.
- **MediaWiki**—This free open source wiki software is available for installation on web servers by IT specialists or those familiar with PHP scripting language.

Many LMSs, such as BlackBoard, Canvas, and Moodle, could have wikis as one of the resources options built into the LMS or as an available learning tool.

Research indicates that wiki use in K–12 contexts often involves constructivist pedagogies involving peer writing, comments, and revision activities (Hew & Cheung, 2013). For example, Portier and Peterson (2016) conducted action research with fifth and sixth graders who collaboratively conducted research, jotted notes, and wrote paragraphs about a social studies topic. The researchers/teachers discovered that students were open to revision, revision occurred often (average 72 revisions), and most revision was at the word or phrase level rather than sentence or paragraph, but there was imbalance in students' engagement in revision. In another study, wiki usage was shown to increase motivation, perceived usefulness, and ease of use of wiki for writing among English as a second language (ESL) students (Chen, Chuan, Tho, & Teh, 2015). Research by Eteokleous, Ktoridou, and Orphanou (2014) emphasizes the importance of teacher presence in wiki activities, meaning that teachers need to lead students through the student-centered activity with enough support, guidance, assistance, and encouragement toward collaboration.

WIKI INTEGRATION STRATEGIES Wikis support multimodal content, such as text, video, audio, and images, so their uses are quite varied. The following list highlights some common integration approaches:

- **Collaborative student workspaces**—Most integration with students involves them in collaboratively building knowledge toward a common task, such as cross-national, scientific research among high school students (Chia & Pritchard, 2014), and raising awareness of challenges that sea lions face in a Global Classroom Project (Devine, n.d.). Some studies, though, show low social presence among learners, meaning that they did not feel the need to cooperate or collaborate online (Eteokleous et al., 2014; Portier and Peterson, 2016). Teachers should teach students how to use the discussion and commenting tools in the wiki as well as articulate substantive reasons for their use.
- **Student portfolios**—Wikis can support student portfolio development with its ease of editing, commenting, and discussion features, which can assist student reflection as well as reviewer feedback.

Technology Integration

Example 7.2

TITLE: Wiki Tales

CONTENT AREA/TOPIC: Language arts, literacy

GRADE LEVELS: 6–8

ISTE STANDARDS•S: Standard 6—Creative Communicator

CCSS: RL.6.2, SL.6.1, SL.7.1(c), W.8.3.

DESCRIPTION: Divide students into groups of two or three. Using wikis (your school may have a wiki and there are free wiki sites available, such as Wikispaces), have each group begin by creating a page and collaboratively writing an introduction to a story. The introduction must include enough unique characters so that each group member can focus on at least one. Students should discuss what will happen to these characters and how their stories will diverge and then weave their stories together at the end. Each group member will create individual pages about her or his chosen character(s) linked to the collaborative group introduction. Encourage students to brainstorm with their group members for ways that they can link back to common pages where their characters interact with each other. Groups can also include images and outside links within their stories that help convey their tale and the personalities of their characters. The project can be extended by having groups try to link their stories to other groups' stories within the class and/or by having groups edit each other's work.

SOURCE: Based on the lesson Collaborating, Writing, Linking: Using Wikis to Tell Stories Online at the readwritethink website. http://www.readwritethink.org

- **Teacher resource-sharing sites**—Teachers have used wikis to collaboratively build new lessons and ultimately share them with teacher peers (e.g., Chen, Jang, & Chen, 2015).

Technology Integration Example 7.2 illustrates a lesson in which students co-create a hypertextual story using wiki technology.

Video- and Photo-Sharing Communities

Video- and photo-sharing communities (e.g., YouTube, TeacherTube, Tumblr, Vimeo, Instagram, Flickr, Vine) are websites that provide users with easy-to-use tools to upload video and photo files to a server for online sharing with either selected or all viewers. Teachers and students can comment on the videos and photos, tag (i.e., attach keywords to) the content for increased ease of searching, and rate the quality of content. Of young adults ages 18–29, 59% use Instagram (Greenwood, Perrin, & Duggan, 2016). Teachers who use **flipped pedagogy** often introduce students to its concepts via **vodcast** before coming to class and then spend class time on other learning activities. Teachers and students also use secure photo-sharing sites, such as ClassBoard, HomeRoom, Classroom Share site on Shutterfly, and SeeSaw, to assemble evidence of learning activities during the school day for parents' viewing. In most sharing sites, parents can leave comments. Later in this chapter, we describe how teachers and students create video content.

Social Networking Sites

Social networking sites (SNSs) are websites that give members a space in which they can create a personal profile, contribute content, and connect and interact with others. These sites also make it possible for members to contribute to blogs and share media such as images and videos. SNSs include Facebook, LinkedIn, Ning, and Edmodo. The most common SNS is still Facebook, which 79% of online adults use (Greenwood et al., 2016). Because Facebook allows users ages 13 and older, it is applicable for use among secondary students only, assuming that school or district policies allow it to be used. LinkedIn tends to be used by professionals (rather than adolescents), such as teachers, to network with others. Edmodo was created for teachers, schools, and districts, so it

Video Example 7.2 Using Social Networking Sites in School

In this video, a principal tells how teachers use SNSs to communicate with students and coordinate their work.

is the most widely available commercial educational SNS. Some schools have created SNSs using open source software such as Moodle and Elgg.

RESEARCH PERSPECTIVES ON SNSs While research of Facebook use in K-12 settings is still nascent, Manca and Ranieri's (2016) review of literature indicated that Facebook has been used for (1) formal use in formal learning settings, (2) informal use in formal learning settings, and (3) use in informal learning settings. Affordances noted for the use of Facebook included its propensity for popularity among target learners, mixing instructional materials with other informational resources that emanate outside the classroom, combining a classroom context with a personal setting, and drawing outside-of-classroom expertise, yet these affordances often were not evidenced in the studies. The feature found to be most often used was the Facebook group for the purposes of discussion, peer learning, and sharing resources. Kirschner (2015) argues that Facebook is inappropriate for argumentation and knowledge construction because it favors narcissistic contributions, tends to connect like-minded people, and has a linear structure. These studies emphasize the need for teachers to think deeply about the technology's fit with pedagogical and content needs. Aaen and Dalsgaard (2015), however, found that Facebook groups established and used by secondary students served as an important third space, combining school and personal life, and were used for help on educational tasks.

Edmodo, as an educational SNS, has features akin to many LMSs but with aesthetics and some functions of an SNS. In a study by Batsila, Tsihouridis, and Vavougios (2014), junior high school teachers used Edmodo frequently, felt that it was easy to use, was motivating for students, and helped teachers greatly with their work. Teachers identified "excellent" features of Edmodo as including a library, online assignments, message posting, quizzes, online interactions, and text/email. Disadvantages included students forgetting their access codes and their high motivation to use Edmodo leading to other missed responsibilities. In another study, teachers using Edmodo led to the emergence of flipped pedagogy with incorporation of video content (Wallace, 2014).

SNS INTEGRATION STRATEGIES The highly social nature of SNSs makes them ideal for keeping in touch with parents and carrying out collaborative and constructivist, discussion-based strategies. The more common of these strategies include:

- **Communicating with parents and community members**—Schools can invite parents and other community members to join their SNSs and keep apprised of school

events and achievements. SNSs also provide stakeholders an additional way to keep communication lines open with educators about issues of mutual concern. Daren (2016) suggests creating a closed classroom Facebook group for parents and secondary students as another way to share materials and reminders and answer questions. Edmodo can be used for the same purposes. Chairatchatakul, Jantaburom, and Kanarkard (2012) found that social networking created increased parental involvement.

- **Collaborating and commenting on student work**—SNSs are frequently used as collaborative spaces for teachers and students to work together. For example, Hammett (2013) describes a project in which ninth graders studied Shakespeare's *Romeo and Juliet* and created collaborative digital projects that included e-zines, presentations, digital videos, and photo-stories. They used an SNS called Ning to share their products and to communicate about them throughout the unit.
- **Professional learning and sharing**—Hughes, Ko, Lim, and Liu (2015) found that about 10% of preservice teachers used LinkedIn and about 22% used general SNSs for professional activities, and they recommend that teachers develop into connected educators (Nussbaum-Beach & Hall, 2012; Wong, 2013) who can collaborate, interact, and build knowledge with peer teachers by joining interest-driven, participatory social networks. Rodesiler (2015) examined five English teachers' self-directed digital SNS activities and found that their SNS participatory activity involved supporting other teachers, seeking support from others, collecting and curating ideas, and sharing and promoting their developed web-based resources.

Check Your Understanding 7.2

Shared Writing 7.1 Use of Web-based Collaboration Resources for Learning

Web Design and Development

An array of web design and development tools is available for teachers and students to create web pages and websites. This section describes web authoring tools, media resources for web pages, design perspectives that influence development, a recommended development sequence, and an evaluation checklist for judging website quality.

Web Authoring Tools

Computer code underlies every web page and website. Many **web page editors**, such as Google Sites and Wix, offer visual development without coding. Even professional tools including Adobe Dreamweaver generate code automatically, but web developers should know about the major web authoring languages in order to make minor adjustments to developed pages or to troubleshoot problems as they occur. This section introduces web authoring languages that also facilitate creative designs that go beyond visual website templates. Programming languages often used in web development include Hypertext Markup Language (HTML and HTML 5), Java, ActionScript in Adobe Flash, and others. Programming languages for coding apps are Java and Python. Also described here are web page and website software tools that allow teachers and students to create web products without programming.

HTML AND HTML 5 **Hypertext Markup Language (HTML)** is the Internet standard for formatting and displaying web pages. HTML 5 is the latest revision of the HTML standard and has become mainstream because Adobe **Flash** is not supported on products such as the Apple iPad. For developing Apple web pages, HTML5 can be used instead of Flash.

JAVA AND JAVASCRIPT **Java** is a high-level programming language developed by Sun Microsystems. A language similar to C++, it was originally developed for general use but has become popular because of its ability to allow users to create interactive graphic and animation activities on web pages. Many Java applications, called Java applets, are available online for downloading and can be run on any computer that has a Java-compatible web browser. Java was once extremely popular because it made web page features such as animations and special effects, graphics and buttons, interactive displays, and web data collection forms possible. **JavaScript** is an object-oriented scripting language that is client side, meaning that it is implemented as part of a web browser. JavaScript and other programming languages, such as Java, and C++, are used to create dynamic websites.

ACTIONSCRIPT IN ADOBE FLASH **ActionScript** within Adobe Flash software provides an advanced authoring environment for creating content for the web, a mobile device, or virtually any digital platform. In applications ranging from instructional media and games to interactive websites, Flash can take a typical HTML-designed website and make it into an interactive experience.

MOBILE APP PROGRAMMING LANGUAGES With the explosion of mobile devices, many computer science courses have begun app development courses. Depending on the device on which the mobile app will run, it can be programmed in **Python**, Java, C++, Ruby, JavaScript, or combinations of these.

WEB PAGE EDITORS As introduced in Chapter 4, teachers and students can use web design software to develop web pages without programming languages. These **What You See Is What You Get (WYSIWYG)** tools include Google Sites, Weebly, WordPress, and Wix. View the Adapting for Special Needs feature in this chapter to learn about web accessibility for learners with special needs.

Resources for Final Site Production

Websites nearing completion could need media resources for aesthetic or content purposes. Once complete, a website requires hosting on a web server.

MEDIA RESOURCES Many of the media resources introduced in this book can be used within websites. See Table 7.1 for common media elements and the roles they serve in websites.

Box 7.1: Adapting for Special Needs

Online Teaching and Learning with Web-Based Tools

At the present time, there is limited evidence to suggest that students with disabilities are equitably represented in online classes and virtual schools (Center for Online Learning and Students with Disabilities, 2012; Vasquez & Straub, 2012). This suggests that administrators might need to be more attentive to access barriers found within the learning management systems and software that they use to deliver online learning instruction.

When purchasing new online learning systems, administrators should ask vendors to provide a Voluntary Product Accessibility Template (VPAT) for each of their products. The VPAT is essentially a certification that the vendor provides to customers concerning the accessibility of their product. This is often a requirement in state/district procurement processes. It is a voluntary document indicating compliance with federal accessibility laws. Learn more by going to the Information Technology Industry Council website and searching "accessibility."

—Contributed by Dave Edyburn

Table 7.1 Media Resources for Website Development

Types of Resources	Examples	Roles in Websites
Audio	• Digitized music, speech, or sound effects • Recorded sounds—Authors' or others' voice recordings	• Background music for presentations • Illustrations of musical types • Portions of famous speeches • Readings of poetry • Directions to students • Sound effects to add interest or humor or to signal transitions • Teacher and student generated podcast audio files
Video	• Digitized videos—Imported from digital video cameras and edited with movie editing software • Recorded video from live webcam • Collections of prerecorded video clips • Screen capture video	• Demonstrations of procedures (e.g., labs, sport movements) • Recorded lectures • Illustrative examples of topics being discussed • Video decision-making simulations • Video problem-solving situations • Screen capture video for software demonstration
Photos	• Digitally scanned print photographs • Freeze-frames captured from video sources • Digital camera images • Stock photography collections or Creative Commons licensed photos	• Historical events, documents, or famous people • Geographical locations or objects in outer space • Illustrative tools (e.g., machines or art implements)
Graphic images	• Created or imported images from draw/paint software, clip art collections, or scanned from drawings or hard copy images • Animations • Infographics	• Illustrative cartoons (e.g., political) • Attention-getting cues • Introductory animations for websites and software • Charts and visualizations
Text	• Composed text • Graphically design text	• Signs or titles • Summaries of written procedures or explanations • Definitions

WEB HOSTING SITES Once teachers and students have programmed web pages using any of the processes previously discussed, the documents containing the code must be uploaded to a **web server**, a computer connected to the Internet that uses software, such as Apache, to send the coded files out to the web and respond to user requests, such as interactive features like playing videos or collecting information from web forms. A school or district can have a web server or contract with a **web hosting** company to provide this service.

Design Perspectives

Teacher and student web developers can leverage perspectives from multiple disciplines to contribute to better websites.

MUSIC, SOUND, AND ART AESTHETICS Visual arts and music play major roles in the effectiveness of websites. As teachers and students gain more knowledge in the theory and the aesthetics of music, sound, and art, they will use these resources more productively in the authoring process, ultimately enhancing the quality of their media development.

GRAPHIC DESIGN PRINCIPLES Many principles of desktop publishing also apply to web design. When students first see the array of graphics and sound options available, they typically use so many colors, graphics, and sounds that they overshadow the message.

VIDEO DESIGN PRINCIPLES For video products, skills are needed in effective ways to illustrate concepts by using motion and camera effects. Authors also learn how to edit video sequences and apply print and animated effects in their video projects.

Web Development Steps and Evaluation Criteria

This section offers seven steps for efficient website authoring and a website evaluation checklist for content and design.

STEP 1: REVIEW EXISTING WEBSITES Review other websites to look for design ideas. This is an important part of the learning process of communicating digitally. Even experienced designers spend a great deal of time viewing websites to learn and understand how to display information effectively.

STEP 2: WIREFRAME OR STORYBOARD Planning and designing a website is the most difficult and important—and most frequently neglected—of all the steps. Most people want to get right to the fun of development, but professional media creators have learned that this kind of planning saves time in the long run. Even famous movie directors, such as Alfred Hitchcock and Steven Spielberg, were known to have storyboarded entire movies before taking a single camera shot because they found that being able to visualize how the product should look and how segments would work together prevented needless reworking. This planning step calls for **wireframing**, **storyboarding**, or mocking up a blueprint for what should appear on each page and how the pages will work together. To do this step, map out the pages in terms of functions, giving a general idea of content on each page and showing how users navigate from one page to another. A useful resource for accomplishing this step is cognitive mapping software such as Inspiration, or even sticky notes placed on large pieces of poster board to represent the web pages. Storyboards should include sketches of information, navigation elements, photos, and details on other graphic elements on each page.

STEP 3: DEVELOP PAGES AND MEDIA ELEMENTS Using the wireframe, develop your individual pages and create all media sources by inserting the interactive elements, media, links, and any other features you want on your site.

STEP 4: ADD NAVIGATION LINKS After developing individual pages, add navigation links that connect pages together into a functional site. The use of storyboards is also helpful at this stage.

STEP 5: PREVIEW AND REVISE Developers should always test how the website looks in multiple web browsers and on mobile devices as they develop it. Many development programs have a built-in preview system, but it is essential to preview the site to observe how it will work when it is published on the web.

STEP 6: PUBLISH For others to see the newly created website, upload your web content to a web server. Everyone remembers website **URL** addresses that are simple and reflect the content of the website. Website developers can purchase a **domain name** that is simple and easily remembered and reflects the website's content. Website domain names can be purchased at numerous places, such as Network Solutions, GoDaddy, and Register.com.

STEP 7: MONITOR, REVISE, AND MAINTAIN THE SITE The best websites are those that are updated regularly based on user feedback and the continuing insights of the developer. User feedback can be obtained from interactive forms built into the page, through inviting emailed comments, and through data analytics, such as Google Analytics.

WEBSITE CONTENT AND DESIGN EVALUATION As students create their own websites, it is helpful to give them criteria in the form of rubrics that describe the quality they are aiming for in each of several aspects. Use The Website Content and Design Evaluation Checklist in Figure 7.2 as a simple checklist, rubric, or guide.

Application Exercise 7.1 Web Authoring Skills and Resources

Figure 7.2 Website Content and Design Evaluation Checklist

Site Name: _____ **Topic:** _____

Site Purpose (check one):

_____ Business _____ Entertainment _____ Instructional _____ News _____ Personal _____ Political _____ Other

URL: _____

Criteria	Yes	No
Site Authors and Sponsors		
Site author(s) and/or sponsorship are(is) clearly identified.		
Author(s) is/are clearly qualified to present reliable information on the topic.		
Contact is provided so site users can ask questions and get further information.		
Comments Related to Site Author/Sponsor:		
Content		
All information is the most current and up-to-date available.		
All information is factually accurate.		
The site is complete (i.e., no "under construction" signs).		
The site has a creation and/or revision date.		
Sufficient information on the topic is provided; it is not missing key elements.		
Appropriate helpful links to other related sites are provided.		
Content is free from typos and misspellings and from punctuation and grammatical errors.		
Content is free from ethnic, slang, or rude names or words; information is presented in a professional manner.		
Content sources (including sources of graphics) are properly referenced.		
In informational sites, content is free from bias. In persuasive sites, author bias is clearly stated.		
Comments Related to Content:		
Organization and Navigation		
Pages load quickly.		
Every page shows clearly how to navigate to parts of the site.		
Content is organized and presented in a logical way.		
Menus, site maps, and other navigation tools are used effectively to aid navigation.		
The product has a consistent look and feel throughout.		
Links all work as indicated.		
Users can get to any content within three clicks.		
Comments Related to Organization and Navigation:		
Visual Design		
Use of fonts and type sizes is controlled so as not to interfere with readability.		
Screen design is optimized for use on smaller-screen devices.		
Color contrasts with background for easy reading.		
To add interest and motivation for users, information is presented in an innovative and creative way.		
Comments Related to Visual Design:		
Media		
Graphics, videos, and sound are included to help communicate information on the topic; their purpose is not just decorative.		
Audio is audible and understandable.		
Video content is clear and visible.		
No obscene or rude graphics or visuals are included.		
Use of graphics (e.g., images, animations) on a page does not distract from reading.		
Pictures and sounds associated with buttons and links are appropriate to the purpose and content of the frames.		
Comments Related to Media:		

Check Your Understanding 7.3

Online Design, Creation, and Making

As noted in the introduction to this chapter, it is often difficult to separate out the communication, collaboration, design, creation, and making activities facilitated by the web because they are often intertwined as features in one web resource or as components in an overall web activity. Consider this last section a culmination of the chapter in which the design, creation, and **making** activities that teachers and students can engage in with web-based resources (that often use communication and collaboration) are described. With the presence of the Internet and the web, students now seek meaning across a range of media, such as text, video, images, sounds, animations, and interactive elements, that are built into web-based resources they interact with daily. Teachers now can expand opportunities for learners to widen the range of self-expressions to include the **multimodal** expressions. All of the activities in this section yield multimodal creative expressions.

Learners typically are creating expressions of knowledge to represent what they have developed through learning activities and engage in the process of **transmediation** in which learners translate information content from one sign system, such as an oral lecture and reading a text, into others, such as an infographic and film. Park (2017) summarizes several benefits for learners who create multimodal expressions through transmediation:

- Better understanding of the content under study
- Engagement in complex cognitive processes, such as comprehension, mental representations, transfer, and application
- Analytic oral conversations between collaborating students about the known content and new multimodal representations of the content

The multimodal creative expressions in this section range in their complexity and involvement of digital technologies, although all involve learners engaging in a **design process** when they create and make. Table 7.2 summarizes the six steps of the design process with descriptions of the process for each type of creative activity described in this section.

Multimodal Representations

Chapter 4 introduced the ways that teachers and students often need to represent concepts to others, whether it is for teaching content concepts or demonstrating students' developed knowledge. This section focuses on the most basic and commonly used multimodal creative expressions when students use web-based tools to join multiple digital elements to create multimodal representations. Review Table 7.2 for an example design process involved in creating multimodal representations.

WEB-BASED PRESENTATIONS Numerous web-based presentation-type tools allow students and teachers to create slides with multimedia elements to communicate ideas. Many of the building blocks of representations described in Chapter 4, such as graphical images, can become media elements in a presentation. All can be shared via YouTube, TeacherTube, GoogleDrive, Edmodo, and other syndication systems for easy consumption or collaboration with others. Some web-based presentation formats teachers or students can create include:

- **Narrated slidedecks**—Create narrated slidedecks using PowerPoint and its voice annotation features, EduCreations, Prezi, Adobe Voice, VoiceThread, and Buncee.
- **Animated videos**—Develop narrated animated videos that can be used to illustrate learning and to instruct using PowToon, GoAnimate, Voki, and ToonTastic.

Table 7.2 The Design Process in Web-Based Creation and Making

	Six-Step Design Process					
Web Creation Activities	**1. Define the problem or task**	**2. Collect information**	**3. Brainstorm and analyze ideas**	**4. Develop preliminary solutions**	**5. Gather feedback from others**	**6. Improve through revision**
Multimodal Representations	Determine the content task that will be represented.	Research the topic and/or actively listen or read the content with care.	Sketch the skeleton of the representation you will develop ensuring it fits with the collected information.	Develop the representation with media elements as necessary.	Share and receive feedback.	Revise final representation based on feedback.
Digital Publishing, Storytelling, and Book Making	Identify the topic of the story or book.	Research the topic or generate ideas (if creative writing).	Storyboard and outline; write script if using audio narration.	Initial production using digital software.	Online or face-to-face presentations of stories or books for feedback.	Revision and final online publishing (or print publishing for books).
Digital Portfolios	Determine portfolio requirements.	Plan for and collect learning artifacts.	Plan the portfolio structure (if not assigned).	Add artifacts and commentary using digital software.	Monitor formative feedback frequently.	Continued reflection, collection of learning artifacts, and feedback cycle.
Audio and Video Development	Articulate the need for an audio or visual artifact.	Identify the audio or video content required.	Storyboard audio/video sequences. Begin audio or video recording.	Develop audio or video using editing and sequencing software.	Share with audience who needs or will consume the target audio or visual effect.	Revise as needed, going to back collect more audio and video or more editing, as needed.
Computer Programming	Identify ill-defined authentic problem or game goals (meaningful beyond school context).	Develop ideas and potential solutions to the problem.	Sketch framework for computational artifact; develop component parts.	Orchestrate individual elements or features into an initial, external artifact.	Gather public feedback from authentic audiences (e.g., peers, teachers, programmers).	Revise artifact in response to feedback.

- **Interactive lessons**—Create interactive lessons with images and slides, videos, and other interactive elements for independent or synchronous student use with software such as Near Pod or Pear Deck.
- **Collaborative and interactive whiteboard**—Start with a blank whiteboard canvas on which users can import a range of visuals, animations, videos, pictures, and record narration and share with others using software including Explain Everything, Show Me, and ScreenChomp.

VISUAL REPRESENTATIONS **Sketchnoting**, a type of visual note taking, typically involves creating a visual depiction of an oral lecture, presentation, or content that is read. Often done on paper with pencils (and then photographed and shared online), some digital software, such as Apple's Paper app, Adobe Sketch, Procreate, SketchbookX, Paper53, Tayasui Sketches, Autodesk Sketchbook, and Microsoft One Note, can be used although the user will likely need a stylus when working with a tablet. Students develop active listening and reading and organizational skills when they sketchnote, and Gammill (2016) indicates that sketchnoting is a type of mnemonics and helps learners remember what they learned. Teachers can rotate among students to sketchnote any content lectures or presentations to create a visual archive, which also could become a learning artifact for a portfolio.

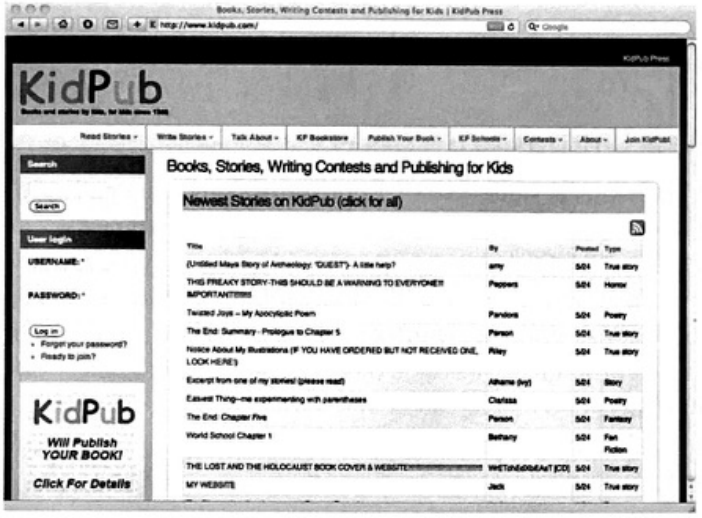
Students also create visually based infographics to represent their learning using tools such as Piktochart, Canva Infographic Maker, Visual.ly, Infogram, and Wordle. Infographics tend to visually represent data-rich concepts, such as science experiment results, historical trends, and mathematical or statistical analyses. Glogster allows students to create a multimedia digital poster.

Digital Publishing, Storytelling, and Book Making

When students submit their written or artistic products to a website, such as an online magazine, they are **digital publishing**. They can use web tools such as wikis and blogs or websites for student authors, such as the Figment, Fan Fiction, KidPub,

Figure 7.3 KidPub Website

Source: KidPub website. Copyright 1995, 2013 KidPub Press LLC. Reprinted by permission. http://www.kidpub.com



Midlink Magazine, Your Student News, or host their own K–12 newspaper with Student Newspapers Online, which charges an annual fee to host a school newspaper. It offers free templates modeled on actual newspapers that schools can use for their own designs. The KidPub website (Figure 7.3) hosts student work samples from around the world.

Digital storytelling is the process of using images and audio to tell the stories of lives, events, or eras. The StoryCenter site indicates that a digital story is a narrative someone tells in the first person in video format. StoryKit app (ICDL) helps users write, illustrate, narrate, add sounds, design the layout, and share a story. Users also have access to children's books in the public domain to adapt or remix. Storybird app allows users to write stories and poetry, use presupplied art to illustrate their books, share them, and comment on other books. The Sway app creates interactive stories, presentations, and other communications with templates. Students can also use publishing and presentation software described in Chapter 4 for digital storytelling.

Book making involves designing and producing e-books or printed books using book development software, such as iBooks Author, BookCreator, Adobe InDesign, and wiki and blog technologies. For example, a fifth grade teacher worked with her students to publish science-related e-books using iBooks (Encheff, 2013). Mr. Smith's fifth grade special education class at Gibbs Elementary School wrote and published *The Two Kids and Desert Town* (2012), freely available on iTunes. Another iTunes book, *Creatures, Plants and More! A Kid's Guide to Northwest Florida* was created by seventh graders in 2012, and sixth and seventh graders created the *Wild Wonders of Science* in 2014.

All of these publishing efforts share students' creative expressions with authentic audiences and engage students in a design process. Review Table 7.2 for an example design process involved with digital publishing.

Video Example 7.3 The Creation of a Digital Book

In this video, seventh grade students introduce the history book project they completed and published using wikispaces.

https://youtu.be/hVUivWx8vPE

INTEGRATION STRATEGIES FOR DIGITAL PUBLISHING, STORYTELLING, AND BOOK MAKING Teachers and students can consider the following multimodal expressions for digital publishing, storytelling, and book creation: cookbooks (science, social studies, health), field or nature guides (science, social studies), creative writing (English language arts), and textbooks (all areas).

Web-Based Digital Portfolios

As described in Chapter 4, student **digital portfolios**, which are collections of work on a website or as a multimedia product, are created so that the learners and others can see how their skills and knowledge have developed and progressed in relation to learning goals or outcomes over time. To build these portfolios, students engage in a design process that emphasizes reflection, which contributes to deeper understandings (review Table 7.2). Digital portfolios can be created in portfolio systems, such as SeeSaw, Three Ring, and DIGIcation, or by using Adobe Acrobat Professional, websites, blogs, wikis, and presentation software. Learning artifacts can include any digital products, such as scanned print artifacts, photographs, and video.

Audio and Video Development

Once the exclusive domain of media professionals, audio and video content can be produced by anyone; stored on free websites including YouTube, TeacherTube, and Vimeo; and easily shared by using any SNS. Teachers are taking advantage of students' desire to produce and use online audio and video content by both including it in their own lessons and allowing students to create their own videos that show what they have learned. This section provides background on audio and video production and describes integration strategies for incorporating these online media for learning. Review Table 7.2 for an example of a design process involved with audio and video development.

CREATING DIGITAL MEDIA FROM IMPORTED FILES Audio and video files can be imported onto a computer from a source, such as a phone, digital camera, or **webcam**, in one of several formats (e.g., **Audio Video Interleave (AVI) format, Moving Picture Experts Group (MPEG or MP4) format, QuickTime movie (MOV) format**). Once stored on a computer, the resulting digitized clips can be used in multimedia software or uploaded to the web. Media clips stored in this way are often viewed with free player software, such as Apple's QuickTime and Windows Media Player. **Video editing software**, such as iMovie and Windows Movie Maker, allows digital videos to be edited and combined with special effects, such as titles, screen fades, transitions, and voice-over audio/sound effects. YouTube has a Creator Studio that offers audio and video editing tools. If teachers need audio to post only a musical selection or a lecture, software, such as Audacity and GarageBand, is available to allow audio recording and editing. An example screen from an open-source video editing software is shown in Figure 7.4.

The top of the screen in Figure 7.4 offers video editing options, and the bottom part allows users to manipulate the audio track. By sliding markers on these tracks and dragging the video clips to their intended destinations in the file, students can cut, copy, and/or paste sections of a video and/or combine them with special effects such as fades or background music. The end result can then be uploaded to a website such as YouTube and Vimeo.

Depending upon the video-based project students or teachers are pursuing, a classroom might create mini-filming studios or **green screens** to facilitate recording. In Figure 7.5, students have created a set for film production.

CREATING DIGITAL MEDIA WITH SCREEN-CAPTURE SOFTWARE Another way to produce videos for instructional use is through **screencasting** software, such as Screencast-o-Matic, Camtasia, Jing, and Filmora video editor, that allows recording

Figure 7.4 Sample Video Editor: *Open Movie Editor*
Source: *Open Movie Editor* Reprinted by permission. http://www.openmovieeditor.org

of on-screen activity (e.g., typing and cursor motions) and accompanying voiceovers, annotation (e.g., circling or highlighting certain words or actions), editing, and sharing. Once created, teachers and students can upload videos to YouTube, TeacherTube, GoogleDrive, Edmodo or other syndication systems.

CREATING PODCASTS, VODCASTS, AND VLOGS **Podcast**, a term that combines "iPod" and "broadcast," coined by British journalist Ben Hammersley in 2004, originally meant broadcasting audio via a website, such as iTunes. Vodcasts can also mean posting video on an online site such as YouTube, a practice also sometimes referred to as a vodcast or **video sharing**. Video can also be incorporated into a blog, called a *vlog*,

Video Example 7.4 Do It Yourself Green Screen

This video shows how to create an inexpensive green screen, which facilitates the use of a chroma-key, a visual effect allowing layering one object (such as a person) in front of another still or video background.

https://youtu.be/KcIldwox6HE

Figure 7.5 Film Set in a Classroom
(Photo by W. Wiencke)

Video Example 7.5 Flipped Learning Science

This video shows example snippets of teacher-produced screencasting videos about science concepts for their learners.

https://youtu.be/21BR6vqYWC8

in which posts are video clips instead of text entries. Audio and video have evolved into a new form of multimedia publishing used around the world by people of all ages.

AUDIO AND VIDEO LESSON INTEGRATION STRATEGIES As Rudd and Rudd (2014) observed, video is becoming much more prevalent in online and blended courses. Students and teachers are using audio and video they have created and placed online for a variety of purposes ranging from presenting the daily school news to creating video lessons that enable a flipped classroom model. Some of these media-based strategies are described here.

Demonstrations of Frequently Performed Procedures. For activities that are frequently repeated (for example, procedures for science experiments), teachers can film themselves or others completing the steps. These short clips, which provide demonstrations that can be viewed and repeated as many times as desired by students, are useful across curriculum areas, such as demonstrating fitness and sports skills and methods (Shumack & Reilly, 2011), reminding students with cognitive disabilities of frequently used steps (Brown, 2010), and for **video modeling**, which has been used successfully to build social and communication skills in students with emotional and behavioral disorders (Hong et al., 2016; Losinski, Wiseman, White, & Balluch, 2016). Sharing video demonstrations on the web allows other teachers to use them, saving both money and time (Ehrmann, 2011).

Student-Created Audio-Visual Presentations. Students can create videos that illustrate real-life examples of concepts they have learned (e.g., showing how algebra applies to everyday situations) or make documentaries of events and conditions around them. Bedrossian (2010) described how students interviewed, recorded, and made podcasts of oral histories of people who lived during important scientific and technological discoveries. Criswell (2013) described making video recordings of students' musical performances as a way to help them self-assess their work. Ezquerra, Manso, Burgos, and Hallabrin (2014) found that secondary students who made documentary videos of kinematics increased both their digital literacy and scientific knowledge. Lee (2015) examined how fifth grade students used high-speed cameras and stop-motion animation, such as FramebyFrame, to understand human biomechanics, and results indicated that the students developed more accurate scientific representations. In addition, with careful review of copyright, students could be able to use video content from local or distant webcams to explore phenomena in their own video production as illustrated in the Technology Integration Example 7.3.

Documentation of School Activities. In many schools, students produce a daily video news show or the morning announcements. Students are the news anchors, the camera operators, and the video production team. Students develop research and interviewing skills, oral presentation skills, and technical production skills. When schools create video yearbooks, students capture video clips of events and merge them into a collage of the year's events.

Amateur Filmmaking. Gran (2015) positions filmmaking as applicable across the K–12 arts curriculum, but it is also well positioned to support cross-curricular projects

Technology Integration

Example 7.3

TITLE: Archived Webcam Video Brings Weather to Life

CONTENT AREA/TOPIC: Science, physical sciences

GRADE LEVELS: High school

ISTE STANDARDS•S: Standard 3—Knowledge Constructor; Standard 4—Innovative Designer; Standard 6—Creative Communicator

NSTA: HS-ESS2-4, HS-ESS2-5

DESCRIPTION: Teachers who want a vivid and engaging way for students to examine physical science and weather concepts can create classroom activities around copyright-free webcam images and archived video of local or distant locations. For example, students can examine and download flood cam video from various locations, which provides readings of a river's height along with corresponding weather data. Students then design a film illustrating key scientific physical weather concepts and the resulting impact on the physical world. Gathering local and distant weather events, students can understand how physical science concepts apply to real-world events.

SOURCE: Based on a concept from *A Study in Natural Disasters* at the Education World site.

(Burn, 2016). Meager (2017) describes how children as young as 10 years old can engage in observational filmmaking, which helps them to build new understandings about their own lives, a type of participatory video pedagogy. Researchers have illustrated that filmmaking engages students in collaborative, multimodal literacy practices (Burn, 2016; Husbye & Vander Zanden, 2015). Secondary students have developed historical documentary films (Schul, 2014). Lorenzi (2012) suggested six genres for student films, including (1) the interview, (2) field (trip) correspondent, (3) the sequel to a story, (4) a commercial or PSA, (5) historical reenactment, and (6) tour guide. For longer projects, core-curricular area teachers might need to collaborate with the arts and/or computer teachers. In Technology Integration Example 7.4, students extend a book's story as a film.

Technology Integration

Example 7.4

TITLE: Students as Feature Filmmakers

CONTENT AREA/TOPIC: Language arts

GRADE LEVELS: Elementary to middle school

ISTE STANDARDS•S: Standard 4—Innovative Designer; Standard 6—Creative Communicator

CCSS: RL.6.2., W.6.6, SL.6.1, SL.7.1(c), W.8.3, CCSS. ELA-LITERACY, SL.8.5

DESCRIPTION: Students choose a favorite book and brainstorm what might happen to the characters after the end of the story. Then they work in small groups to write their own sequels and film them. Each group creates storyboards to map out the setting, action, and dialog. Finally, they role-play and film the sequels. An alternative is to use photos or scanned illustrations for a narrated slide deck or an animated video. With any format, students can insert a musical sound track or dub in their own narration over the pictured or filmed events, depending on their skill levels.

SOURCE: Based on a concept from *Creating Future Filmmakers* by Natalie Lorenzi (2011) in *Instructor, 121*(6), 57–58. Retrieved from http://www.scholastic.com/teachers/instructor

Video Example 7.6 Student-Created Film

The White House hosted a student film festival as part of its South by South Lawn (SXSL) event in 2016. Seventeen-year-old Jason Cordis directed the film shown in this video, which was 1 of 15 finalists in the SXSL festival, about Takeshi Tanemori, a survivor of the Hiroshima bombing.

https://youtu.be/YClzlUdGrRA

Computer Programming

A growing emphasis for all children to engage in **computer programming** has surged, possibly because of the perception that **coding** skills could bring economic prosperity when youth enter the workforce and that it enables youth to use web-based technologies more creatively and critically (Burke, 2016). In considering the last 30 years of research and news articles related to efforts to integrate **computer science (CS)** into K–12 schools, Burke (2016) identified three metaphors representing how schools introduce computer programming, including:

1. As a practical approach to mathematics with roots in Papert's Logo programming in the 1970s and 80s (Papert, 1980).
2. As a new literacy, such as computational literacy or simply as another language (coding) for creative expression.
3. As technical skills that move learners beyond Microsoft Office to understand how design, computation, and modeling contribute to making computers and the web function.

Burke (2016) encourages teachers and schools to monitor the metaphors used in their community and possibly to combine them if doing so is advantageous. For example, a school could begin introductory computer programming using metaphor 1 by introducing a practical application such as Scratch, a drag-and-drop programming software, and metaphor 2 by embedding computer programming within activities such as storytelling and art, which have shown success (Kafai & Burke, 2014). They may then transition to metaphor 3, technical perspectives, by teaching game design and development, as learners become more sophisticated in programming. A prominent finding from research is the deep level of collaboration that occurs among learners as they code, create, and make (e.g., Fields, Vasudevan, & Kafai, 2015; Wernholm & Vigmo, 2015). For example, extensive online networks exist where students share the same interests and work on specific computer programming challenges, such as Scratch's website and Minecraft YouTube videos. Thus, computer programming should not be perceived as an individual process. In addition, the benefits of computer programming are its ability to support the development of **computational thinking**, such as skills in abstraction, algorithms, logical thinking, data representations, and problem solving. A significant challenge for schools is deciding where to place computer programming in the curriculum, which has remained unresolved (Burke, 2014); thus, it often occurs within a dedicated computer course or as an after-school club or camp (e.g., Alexander & Ho, 2015; Javidi & Scheybani, 2014). This section reviews prominent strategies for introducing K–12 students to computer programming. Review Table 7.2 for an example design process involved with computer programming.

CODING Hour of Code is a project to introduce all students to computer science by engaging them in a 1-hour activity involving coding. Its website has hundreds of tutorials and activities for teachers to adopt to introduce computer science concepts, some of which do not even require computers. The global Hour of Code typically occurs in December during Computer Science Education Week, but anyone can host

an Hour of Code event at any day or time. Other organizations including Girls Who Code and Black Girls Code encourage girls and girls of color to learn computer programming.

VISUAL PROGRAMMING Scratch is a free, visual-based, drag-and-drop programming software developed at the Massachusetts Institute of Technology (MIT). It allows those new to coding or computer programming an easy entry and scaffolds learners to build interactive stories, games, or animations and share them within a large online community. Students can learn statements, conditions, loops, Boolean logic, variables, random numbers, sequences, operators, parallelism, and lists (Benton, 2015). Fields et al. (2015) examined high school students engaged in programming music videos using Scratch and emphasized that the social and collaborative nature of media design and development contributed to students' learning, evidenced in their designs, in interactive feedback, and in their completed music videos. In another study, Javidi and Scheybani (2014) described high school students who coded in Scratch to build a project that interacts with a Picoboard, a hardware device that allows Scratch coders and their projects to interact with the outside, physical world (as opposed to virtual games or simulations built within Scratch and played on the web). Javidi and Scheybani found that the project led students to increase their understanding of computer programming and gain positive attitudes toward computing.

GAME AND APP DESIGN AND DEVELOPMENT Some teachers create opportunities for students to design and create their own video games or apps using software such as GameMaker: Studio, Gamestar Mechanic, Scratch, and Alice. The design process involves students in using multiliteracies, such as storytelling script writing, drawing, animating, developing computer programming skills, and engaging in computational thinking. For example, Alexander and Ho (2015) describe a 2-week summer program in which secondary students engaged in hands-on, experiential learning to create a 3-D game using tools including Adobe Photoshop, Maya, Roadkill UV, and Unity. At the program's completion, researchers found that students had learned the complexity and multidisciplinarity of game design and development, storytelling elements such as narrative and character development, working with 2-D and 3-D art, peer communication and collaboration, gaming theory and technical skills, problem solving, and conceptual framing. Alexander and Ho's detailed process for making games can serve as a valuable guide for teachers.

BUILDING IN VIRTUAL WORLDS Games, such as Sims or Minecraft, allow learners to build virtual worlds within a multi-player, online game environment. The Sims 3 is a life simulation game in which users design their life and can explore the virtual community. In Minecraft, often referred to as a digital 3-D sandbox, players place square blocks to build objects in the world and use graphics, images, and symbols to enhance the world they built. Minecraft is an open environment with few rules and devoid of traditional game features such as levels and points. MinecraftEdu is a similar environment with features supportive of school-based learning, and it offers a Code Builder extension that allows students to create even more through coding. Youths' creations in Minecraft have been shown to be social and collaborative based on the examination of the profuse knowledge making and knowledge sharing that occurs within SNSs especially in YouTube (Wernholm & Vigmo, 2015).

The educators in this video as well as in other studies (e.g., Marcon & Faulkner, 2016) emphasize how games like Minecraft bridge interests from outside school to inside school, which is a tenet of the **turn-around pedagogy** built into this book's **Turn-around Technology Integration Pedagogy and Planning (TTIPP)**.

Few research studies have examined educational impact of The Sims. However, Méndez, García-Pernía, and Cortés (2014) examined 12–13-year-olds who played Sims 3 along with reflective writing in an online community, which researchers found supported collaborative learning, such as identifying and developing solutions to problems.

Video Example 7.7 The Benefits of Using Minecraft in Education

In this video, educators describe the educational benefits of using Minecraft in education.

https://youtu.be/hl9ZQiektJE

Monjelat, Méndez-Zaballos, and Lacasa (2012) found that secondary students who used Sim City Creator engaged in problem-solving processes with support of their teacher and in-game scaffolds, facilitating their abilities to create in-game representations. Both studies emphasized the importance of collaboration, teacher presence, and scaffolding.

There are also student-friendly programming environments for creating **virtual reality (VR)** that can be used with **head-mounted displays (HMDs)** or desktop computers. WebVR Boilerplate uses JavaScript; A-Frame is an HTML programming environment; Vizor is a visual programming, drag-and-drop environment for building VR on the web. CoSpaces and CoSpaces Edu edition allow VR creation on the web or tablets with or without programming. With these tools, students can program 360 photos, 3-D scenes, architecture or scenes, visual experiments, and interactive VR. A 360-degree camera can be useful for VR development.

The following ideas for integrating virtual world building games into the curriculum (Minecraft, 2017) include:

- Exploring geometric shapes or algebraic patterns.
- Visualizing and creating settings from literature.
- Replicating famous historical places that no longer exist.
- Creating visual poems that players can walk through.

BUILDING AUGMENTED REALITY **Augmented reality (AR)** refers to the combined hardware and software platform that creates a computer-generated environment in which a real-life scene is overlaid with information, such as images, video, sounds, 3-D models, animations, or text, which enhances our uses of it. Mobile phone apps can engage with the AR elements. Studies reveal that the use of AR-enhanced learning experiences has increased or maintained learning outcomes, such as in vocabulary learning (Santos et al., 2016), geometry (Lin, Chen, & Chang, 2015), ecological education (Huang, Chen, & Chou, 2016), skill tasks for students with autism (Cihak et al., 2016), and place-based social studies (Johnson et al., 2017). Yet learners can move from consuming AR to designing and making AR, which yield multimodal creations that develop higher order thinking (Bower, Howe, McCredie, Robinson, & Grover, 2014). Designing and building AR is supported through systems including Aurasma, Layar, colAR, Chromville, and Junaio. BuildAR is an AR content management system for teachers and students to create and manage their AR experiences. The largest challenge is that teachers must have expertise in developing or leading students to develop AR (Bower et al., 2014). The Technology Integration Example 7.5 introduces students learning through designing AR for a sculpture garden.

The following is a range of curricular integration ideas that emerged from an array of resources that position the students as AR creators:

- Create science games with TaleBlazer Editor from MIT (Klopfer & Sheldon, 2010)
- Participate in MIT's Community Science Investigators (CSI) by combining Geographic Information Systems (GIS), TaleBlazer Editor, service learning for investigating local problems, and building AR games to engage the community (Klopfer & Sheldon, 2010)

Technology Integration

Example 7.5

TITLE: Augmented Reality Sculpture Park

CONTENT AREA/TOPIC: Art, technology, science

GRADE LEVELS: Middle to high school

ISTE STANDARDS•S: Standard 3—Knowledge Constructor; Standard 4—Innovative Designer; Standard 5—Computational Thinker; Standard 6—Creative Communicator; Standard 7—Global Collaborator

NATIONAL VISUAL ARTS STANDARDS: Presenting, responding

NGSS SCIENTIFIC AND ENGINEERING PRACTICES: Ask questions (S&EP1); develop and use models (S&EP2); use computational thinking (S&EP5); design solutions (S&EP6); communicate information (S&EP8).

STL STANDARDS: Engineering design (STL9); the role of troubleshooting, research, and development; invention and innovation; and experimentation in problem solving (STL10); application of the design process (STL11)

DESCRIPTION: Collaborate with a local sculpture garden or other outdoor arts-based environment. Students work in dyads or small groups and choose a sculpture (or other artwork) on which to focus their augmented reality enhancements. Students then examine the physical sculpture and research the artist, history, and sculpture development. After an introduction to augmented (AR) reality technologies and the types of the enhancements that they might use, such as videos, animations, audio, links, surveys, or commentaries, the group creates a design prototype for the AR overlays. After presenting the prototype to the class and sculpture garden directors, the group revises the design and confirms the AR overlay features. The group develops the AR multimedia elements, such as videos, images, and text, using a range of other technical tools, such as iMovie and PhotoShop. Using Aurasma, they finalize their AR overlays that are then available to the general public who visited the sculptures.

SOURCE: Based on Bower, M., Howe, C., McCredie, N., Robinson, A., & Grover, D. (2014). Augmented reality in education – Cases, places and potentials. *Educational Media International*, *51*(1), 1–15.

- Build GoogleEarth models using ARSights (Thornton, Ernst, & Clark, 2012)
- Create overlays for significant objects (e.g., sculptures in a garden) in Aurasma (Bower et al., 2014)
- Make AR picture books or visual poems with Layar
- Use Zooburst to create 3-D digital stories with photos, audio, and text

MAKING In school **makerspaces**, students learn to design, tinker, inquire, experiment, and build physical objects, which is referred to as **making**. Code underlies all computational objects, and in some makerspaces, students make physical artifacts that involve computer programming. For example, students can program an open-source, Arduino microcontroller circuit board. Casey Korder's third grade students used an Arduino to illuminate an LED light, and fifth grade students created calculators, mixed color lamps, and a smart nightlight (Cracking the code, 2016). Students have developed Arduino-based electronic textiles with the Lilypad Arduino kit (Buechley, Eisenberg, Catchen, & Crockett, 2008; Burke, 2016). The Raspberry Pi, a low-cost (~$25), credit card–sized, single-circuit board computer, can be used like any computer and with computer programming activities. For example, Michael Geyer, a high school chemistry teacher programmed a Raspberry Pi to count by 1s for his lesson demonstrating the magnitude of a mole by estimating the time a computer takes to count to 6.02^{23} (Geyer, 2014). Raspberry Pis boot up from a Secure Digital (SD) card, so students can decide what operating system and other software, such as a web browser, to use to design a customized computing system (Strycker, 2015). The Makey Makey circuit boards allow everyday objects to become computer-based input devices (i.e., a touchpad), which interact with the web and can be mashed up with other programming tools, such as

Video Example 7.8 3-D Printing Prosthetic Hands

In this video, middle school students describe how they designed and built prosthetic hands using a 3-D printer.

https://youtu.be/48eBfW8HtIY

Scratch, to integrate elements off and on screen. Watkins (2017) described students using Makey Makeys to create musical instruments that then provided background sounds or sound effects to correspond with content in literature books. Sánchez González, Bello, Gómez de Anda, and Servin Guzmán (2017) described how middle school and high school girls designed and created an interactive cell using a Makey Makey; when a learner pressed on a physical organelle (made with recycled materials and circuits), the computer provided more information about the organelle functions. Students also can begin to engage in computer-aided design with BlocksCAD, a web-based, 3-D modeling **computer-aided design (CAD)** software for designing 3-D objects to be printed on **3-D printers**.

As mentioned in Chapter 1, many K–12 schools are establishing a robotics engineering curriculum as an after-school extracurricular activity, part of a STEM curriculum, or an activity within makerspaces. Students assemble robots, program them with code, and control them via various mobile technologies. Lego Mindstorms is a popular robotics kit among youth and teachers. For example, Mak (2014) described how her third and fourth graders' use of Lego Mindstorms for obstacle course challenges led to mathematical reasoning, failure, problem solving, and collaboration. Burton (2014), a science teacher, provided a detailed description of the engineering practices his fourth grade students engaged in to solve a "tightrope" problem in which they had to build a robot to move along a rope and retrieve and drop a suspended ball. Although robotics often is situated as an extracurricular school activity, Williams et al. (2012) developed, taught, and researched three standards-aligned, science and three math lessons that used Lego Mindstorms kits. The 2nd, 3rd, 6th, 8th, 9th, and 10th grade students enjoyed the hands-on learning, and their knowledge of content area concepts gained significantly. Thus, robotics activities can be situated within STEM curricular areas. Regarding increased inclusive participation of girls in robotics, Veltman, Davidson, and Deyell's (2012) youth outreach activities yielded the following strategies:

- Focus on themes rather than challenges
- Combine art and engineering
- Support storytelling
- Offer exhibitions rather than competitions

NASA supports robotics education through the Robotics Education Project (REP), which includes a list of curriculum, competitions, and internships appropriate to K–5, 6–8, and 9–12 grade levels.

Check Your Understanding 7.4

Chapter 7 Summary

The following is a summary of the main points covered in this chapter.

1. **Online communications**
   - Email exchanges are written messages between or among individuals or small groups; listservs store all group members' emails as one mailing list and members use one email to communicate with everyone simultaneously.
   - Instant messaging (IM) and text messaging allow users to see messages immediately in several kinds of Internet-enabled programs or devices.
   - Videoconferencing is multimodal interactive communication that allows those involved to see and hear each other. Participants often use a webcam, a microphone, and speakers or headphones.
2. **Online collaboration**
   - Blogs are web sites for discussing a topic or issue. Integration strategies include engaged writing, collaboration in content area topics, communication among teacher communities of practice, increased interaction with parents and community members, and updates and insights on education topics.
   - Microblogs are micromessage services that others can follow and reply to. Integration strategies include sharing classroom learning, formative assessment, bulletin boards, Twitter walls, role-playing, resource collections, mentors or experts, and professional learning.
   - Content curation tools facilitate collection and organization of Internet-based information. Integration strategies include content collections, photo curation, student research, and lesson resource planning.
   - Wikis are modifiable web pages. Integration strategies include collaborative student workspaces, student portfolios, and teacher resource sharing.
   - Video- and photo-sharing communities allow users to upload and view video and photo files. Education-specific photo-sharing apps facilitate parent–classroom connection.
   - Social networking sites (SNSs) are websites that give members a space in which they can create a personal profile, contribute content, and connect and interact with others. Integration strategies include communicating with parents and community members, collaborating and commenting on student work, and professional learning and sharing.
3. **Web design and development**
   - Web-authoring tools include HTML and HTML 5, Java, JavaScript, VRML, ActionScript in Adobe Flash, Python, C++, Ruby, or a combination of them. Developers also use web page editors, such as Google Sites and Weebly. Media resources for website development include audio, video, photos, images, and text.
   - Web developers can leverage perspectives from music and art, graphic design principles, and video design for web design.
   - Steps for developing websites involve: Step 1: review existing websites; Step 2: wireframe or storyboard; Step 3: develop pages and media elements; Step 4: add navigation links; Step 5: preview and revise; Step 6: publish; and Step 7: monitor, revise, and maintain the site. Websites can be evaluated in five areas: authorship, content, organization and navigation, visual design, media.
4. **Online design, creation, and making**
   - Multimodal representations are created through a 6-step design process and represent content concepts using multiple digital elements. Examples include presentations, such as narrated slidedecks and animated videos, and visual representations, such as sketchnoting or infographics.
   - Written and artistic expressions can be published online or created in digital stories or books. Integration ideas include content-related creations, such as cookbooks, field guides, or creative writing.
   - Digital portfolios can be created as multimedia websites or products.
   - Audio and video creations can be developed from raw audio and video collected and from screen-captured content that is edited to create podcasts, vodcasts, vlogs, and audio/video files. Integration strategies include demonstrations of frequently performed procedures, student-created audio-visual presentations, documentation of school activities, and amateur filmmaking.
   - Computer programming allows students to ground mathematics learning, learn new literacies, and develop technical, computational thinking, and design skills. Common approaches to introducing K–12 students to computer programming include coding, visual programming, game and app design and development, building in virtual worlds, building augmented reality, and making.

Technology Integration Workshop

1. Apply What You Learned

In this chapter, you learned about web-based resources for communication, collaboration, design, creation, and making. Now apply your understanding of these concepts by completing the following activities:

- Reread Mr. Patel's *Flipping for Statistics Mastery* lesson at the beginning of this chapter. Pay close attention to Step 3 of his TTIPP where he identifies the technological possibilities for his problem of practice: getting students to learn data measurement, specifically measures of central tendency. Using your knowledge about web-based communication, collaboration, design, creation, and making resources introduced in this chapter (communication and collaboration resources, website design and development, and computer programming), generate at least one new technological possibility for targeting Mr. Patel's problem of practice.
- Review how Mr. Patel RATified the lesson in Step 5 of his TTIPP as represented in Figure 7.1. Use the **RAT Matrix** to analyze the role(s) and relative advantage that your new technological possibilities (identified in the last step) would have in the lesson. You must reflect on the roles that your identified technological possibilities play as replacement, amplification, and/or transformation of instruction, student learning, and/or curriculum. Do you feel that your proposed technology would provide relative advantage?

2. Technology Integration Lesson Planning: Evaluating Lesson Plans

Complete the following exercise using the sample Technology Integration Examples 7.1–7.5, any lesson plan you find on the web, or one provided by your instructor.

a. Locate lesson ideas—Identify three lesson plans that focus on any of the web-based resources you learned about in this chapter such as:
- Email or listservs
- Instant or text messaging
- Videoconferencing
- Blogs and microblogs
- Content curation
- Wikis
- Video- and photo-sharing communities
- Social networking sites
- Website design and development
- Digital publishing, storytelling, or bookmaking
- Digital portfolios
- Audio and video development
- Computer programming

b. Evaluate the lessons—Use the **Technology Lesson Plan Evaluation Checklist** and the **RAT Matrix** to evaluate each of the lessons you found. Based on the evaluation and your RATification of the lessons, would you adopt these lessons in the future? Why or why not?

3. Technology Integration Lesson Planning: Creating Lesson Plans With The TTIPP Model

Review how to implement the TTIPP Model (see Figure 2.6) for technology integration planning and use Mr. Patel's lesson *Flipping for Statistics Mastery* in this chapter as a model. Create your own technology-supported lesson that uses web-based resources for communication, collaboration, design, creation, and making by completing the following activities:

a. Describe Phase 1—Analysis of Learning and Teaching Assets and Needs:
- What is the problem of practice or main content topic in your lesson?
- What are the technology resources that your students, their families, you, and your school could bring as assets to the lesson?
- What are the technological possibilities for helping to solve the identified problem of practice? Identify the technology(ies) you will integrate into the lesson to ensure that you have the skills and resources you need to solve the problem.

b. Describe Phase 2—Design of the Integration Framework:
- What are the objectives of the lesson plan?
- How will you assess your students' accomplishment of the objectives?
- What integration strategies will you use in this lesson plan?
- What is the relative advantage of using the technology(ies) in this lesson?
- How would you prepare the learning environment?

c. Describe Phase 3—Post-Instruction Analysis and Revisions:
- What strategies and/or instruments would you use to evaluate the success of this lesson in your classroom in order to determine any needed revision needs?
- Add lesson descriptors—Create descriptors for your new lesson (e.g., grade level, content and topic areas, technologies used, ISTE standards, 21st-century learning standards).
- Save your lesson plan with all its descriptors and TTIPP Model notes and share with your peers, teacher, and others.

When you use your new lesson with students, be sure to assess it using the **Technology Impact Checklist**.