

Chapter 4

Technology Device and Software Resources for Classroom Productivity

Learning Outcomes

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

- 4.1 Identify hardware and software configurations that meet teaching and learning needs in the classroom. (ISTE Standards for Educators: 1—Learner; 2—Leader; 5—Designer; 6—Facilitator)
- 4.2 Select integration strategies for writing and publishing software that meet teaching and learning needs in the classroom and reflect learning sciences research. (ISTE Standards for Educators: 1—Learner; 4—Collaborator, 5—Designer; 6—Facilitator)
- 4.3 Select integration strategies for representation of content concepts or developed knowledge that meet teaching and learning needs in the classroom and reflect learning sciences research. (ISTE Standards for Educators: 1—Learner; 3—Citizen; 4—Collaborator; 5—Designer; 6—Facilitator; 7—Analyst)
- 4.4 Select integration strategies for data collection and analysis that meet teaching and learning needs in the classroom and reflect learning sciences research. (ISTE Standards for Educators: 1—Learner; 3—Citizen; 5—Designer; 6—Facilitator; 7—Analyst)
- 4.5 Integrate planning and organizing software that meet teaching and learning needs in the classroom. (ISTE Standards for Educators: 5—Designer; 7—Analyst)
- 4.6 Use material generator software that meets teaching and learning needs in the classroom. (ISTE Standards for Educators: 5—Designer; 6—Facilitator; 7—Analyst)
- 4.7 Adopt assessment software that meet teaching and learning needs in the classroom and reflect learning sciences research. (ISTE Standards for Educators: 1—Learner; 5—Designer; 6—Facilitator; 7—Analyst)

additional PDF copies if needed. Ms. Kiley checked out a wide-angle webcam for the videoconference with the local car salesperson, scheduled the computer lab for the 3 days she would need it, and scheduled drop-in lab time for the 2 subsequent days for individual students to complete their research and reports. On the first instructional day, she would remind each student of their assigned lab station.

Although Ms. Kiley and the technology specialist planned to demonstrate how to use the spreadsheet template, she would check with students individually as they worked in the lab to make sure that they knew how to enter the required information in the cells and could embed their completed worksheet into their report. She prepared a list of local and online car dealership websites as resources.

PHASE 3 Post-Instruction Analysis and Revisions

Step 7: Analyze lesson results and impact

At the end of the lesson, Ms. Kiley reviewed students' work and asked for their comments on how she could make the project even more meaningful. She quickly realized that students who did not have a home computer had been at a disadvantage in completing the work in a timely way. She found that students were fascinated with the instantaneous loan calculations that the spreadsheets computed and usually had completed their spreadsheets correctly. However, although students could answer questions about their loan data, their final reports varied considerably in quality.

Step 8: Make revisions based on results

Because not all students had a home computer with the required software, Ms. Kiley planned to make a special effort to help those students during the lab time and make sure that they knew they could have additional time outside class or before or after school to use the classroom workstations. Also, because students' written reports did not always meet required criteria, she decided to revise her rubric to be more specific and to provide examples of exemplary reports.

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

Ms. Kiley felt that the lesson had helped develop her students' financial loan literacy, so she wanted to share it with other applied mathematics teachers. She submitted a proposal to share the lesson at a local mathematics teaching conference, and it was accepted. For her presentation, she published all the teaching materials using a Creative Commons license on her Google Docs account as "view only" so other teachers could download and use the resources in their classrooms.

Introduction

This chapter reviews hardware and software resources that support productivity for teachers and students who use these productivity resources to plan activities, develop materials, communicate and collaborate with others, and keep records. A key feature of the productivity software reviewed in this chapter is what it lacks: It typically does not contain instructional content material. The power and applicability of these resources lies in teachers' and students' bringing academic content or needs to these productivity resources in order to enhance instruction or learning.

After introducing the range of computer hardware and software configurations your school might have, the other productivity resources are described based on their functions in a classroom. We review many resources for writing and publishing; representing content concepts with multimedia; data collection, and analysis; planning and organizing; generating instructional materials and forms; and assessing student products. Think about how you will put each of these resources to work to become a more productive and powerful teacher.

Application Exercise 4.1 Understanding Ms. Kiley's Lesson RATification

Introduction to Technology Productivity Resources

In order to be productive with technology, a teacher must first identify the available hardware and software resources available in the school and classroom. This section introduces a range of configurations of hardware devices for teaching and learning and software tools that support classroom productivity for teachers and students.

Configurations of Digital Devices

As described earlier in this book, seven types of technology hardware commonly used in today's schools include:

1. Wired or wireless networks that provide access to the Internet
2. Desktop or laptop computers for computing activities
3. Handheld computers or devices for computing activities
4. Display technologies for showing information from computing devices
5. Imaging technologies for creating or manipulating visual data
6. Peripheral input or output devices to extend computing devices' functionality
7. External storage devices or cloud services that store data

All schools and learning spaces serve widely different learners for a range of learning purposes. Therefore, devices in every school and learning space need to be deliberately configured or arranged with pedagogical goals in mind. In this section, we describe a variety of physical arrangements designed for computing hardware that serve specific pedagogical goals. Because there are no perfect configurations, we note the benefits and limitations of the designs for teaching and learning.

INNOVATION STATIONS Some schools are installing **innovation stations** in each classroom (CDW, 2011). These are semimobile or immobile stations that contain a central input/output touchscreen hub where a user can control a computer or laptop, document camera, auxiliary inputs, audio microphone input and output speaker levels, a mounted projector, and screen. These stations provide standardized equipment across classrooms, but the resources can be underutilized if teachers do not need all the equipment. If students use the station's computer for presenting or other work, the teacher could arrange for the students to have a computer log-in code that differs from the teacher's to prevent students' access of teacher-specific software and materials such as **gradebook** software, handouts, and tests. If the school does not already have individual student log-ins, it is recommended that schools create one student log-in code that is easily remembered for the innovation station computer.

THE ONE-COMPUTER CLASSROOM One computing device, such as computer, tablet, slate, or phone, in a classroom tends to enable teacher productivity uses and whole-class, teacher-directed instruction if the device is connected with display technology. In this arrangement, the computing device often is placed on the teacher's desk. Without display technology in the classroom, teachers can use the device solely for their own productivity, such as recording attendance, grades, and material development although some teachers share content on a laptop or tablet in small groups or pass a mobile device around (Brown, 2012). Other teachers may dedicate the computing device as a center or station for students.

To facilitate equitable use by students, some teachers choose popsicle sticks labeled with student names to assign each available computer time until all the sticks (i.e., students) have been selected. Another approach is creating five color-coded groups, whose computer time aligns with days of the week or to group-based projects.

Video Example 4.1 A One Tablet Classroom

In this video, a principal explains how a teacher uses one tablet in her classroom.



To facilitate optimal student use of time while at a computer, teachers should organize materials that students need during computer time and place them near the computer in advance. For example, a teacher can laminate the step-by-step instructions for logging in and for a particular learning task, such as what software to use, what websites to visit, and where to save materials.

CLASSROOM COMPUTERS Some classrooms have several, such as three to five, computing devices. These are more convenient and accessible to both teachers and students than a separate computer lab. Teachers tend to use them in a center where students cycle through technology activities throughout a day or week. Some teachers plan the same activity that all students can perform at all computing stations; other teachers set up each computer as a content-specific center, such as writing, math, or music/art. If the computing devices are physically far from each other, teachers could develop collaborative activities with up to three children at each station. Fewer available computers limit the number of learners who can have hands-on use at one time. Teachers recommend placing computer screens toward the class so that they can monitor computer activity. Teachers who plan to implement collaborative computing activities need to separate the computers far enough to accommodate several children around each device. Teachers can implement fair access to devices with name sticks or pre-set rotation schedules (Brown, 2012).

Some teachers use computing access as a reward for unrelated behaviors, such as following directions or good behavior. Unfortunately, these reward approaches do not provide all children access to computing or technology-based learning activities and undermine the tenets of **turn-around pedagogy** or transformative technology integration.

MOBILE CARTS Some schools establish mobile carts containing computing devices, typically laptops, tablets, e-book readers, or devices such as clickers, graphing calculators, and data probes. These carts are sometimes called “computers on wheels,” or COWs. Most carts have electrical power that supports device charging and syncing while devices are not in use.

The carts’ mobility enables resources to be shared among teachers’ classrooms. However, teachers still must schedule access to the carts, and the number of teachers sharing one cart determines its availability. Some schools or teachers use shared online

calendars to schedule cart usage, allowing teachers to know the location and availability of the carts. Each computing device on a cart should have a unique ID visible to students and teachers.

Teachers must create systems to reduce congestion around carts when getting or putting them away. Some teachers assign a student device monitor from each row or group of desks, to pick up and return devices to the cart's slot labeled with each device's ID. Alternatively, a visible sign on the classroom door can direct each student to pick up devices on "computing days" upon entering the classroom. If students save their work directly on a device, as opposed to on a cloud-based storage area, students must access the same device every work period.

Carts are heavy and sometimes difficult to get through doors and up ramps and require elevators to move to other floors of a building. Unlike labs, the mobile devices require wireless Internet connectivity, can be more easily stolen or broken because of their mobility, lose power while in use, and if they are not properly connected to electricity in the cart are not recharged.

COMPUTER LABORATORIES Computer laboratories, which are easier to maintain and secure than carts, tend to be arranged in a centralized space often with desktop computers that can be wired or wirelessly connected to the Internet and a teaching station that connects to a digital projector. General-use labs tend to be scheduled for whole-class use, and students must leave their classrooms to use them. Teachers often must schedule time for lab activities well (sometimes weeks) in advance, and the labs could be available only several times a month. Networking software installed on an instructor computer can allow teachers to visibly monitor students' computer activity.

Special-purpose computer labs can be arranged to meet special course needs and tend to have specific imaging or peripheral technologies. For example, some labs are designed for:

- Computer programming, game design, and technical courses
- Technology and business education or vocational courses that use computer-aided design and drafting, robotics, or desktop publishing stations
- Musical Instrument Digital Interface (MIDI) music creation
- Language learning
- Audio and video multimedia production

There should be sufficient demand for these specialty resources to create a permanent lab because these configurations tend to isolate resources by course topics and usually exclude many learners who do not qualify for or require the resource.

Computer labs can be in library/media centers or a school's **learning commons**. These labs can serve drop-in use by students, teacher's classes at scheduled times, and students who have designated library time. Recently, the library/media center has become a popular place in K-12 schools to establish **makerspaces**, which are physical spaces with digital and mechanical tools and materials that enable people to design, tinker, and build hands-on tangible products. Usually permanent library or media staff oversee the space and provide ready access to all materials to promote integration of computer and noncomputer resources. Spaces such as these need to establish or change expectations regarding noise levels in them because some activities require talk and sounds that might bother other users.

To maximize student computing time, many teachers provide instructions for a computing activity, such as websites or software to use, and assign students to specific computers before the class enters the lab so students start work immediately. They also can display instructions in the lab. If computers are large and obscure teachers' view

of children, systems to alert teachers about questions or problems include students moving a tethered, bright red plastic cup or plate on the top of computer. For younger children, different colored stickers on the bottom right and left of the screen can assist when giving computer instructions to reference areas of the screen.

STUDENT-SUPPLIED DEVICES Some schools allow students to **bring your own device (BYOD)**, including laptops, tablets, and phones, to school to use for learning. With enough BYOD devices to supplement mobile carts or classroom computers, teachers could be able to adopt integration strategies that require a device for each student. However, teachers can be challenged by technical issues when students' devices and software differ. In addition, schools must establish strong Internet Wi-Fi infrastructure and BYOD acceptable use policies. Many teachers set expectations for computing use at the beginning of each class session verbally and/or with a sign. With planned use, students should have their devices on their desk ready. When the devices aren't needed, students should have their devices put away and on silence mode. Yet, some teachers require all devices to be on desks, not in students' laps at any time.

SCHOOL-SUPPLIED ONE-TO-ONE COMPUTING PROGRAMS Many schools are working to supply all students a computing device, commonly referred to as a **one-to-one computing** program. When all teachers and learners have computing access all the time, it enables integration strategies that require a device for each student. A **meta-analysis** of one-to-one laptop programs found that they had a positive impact across science, writing, math, English, and reading skills, but sometimes the impact did not appear until the second year of use (Zheng, Warschauer, Lin & Chang, 2016). One-to-one programs are expensive to purchase as well as maintain and renew.

In terms of classroom management when students do not take the devices home, Wetzel and Marshall (2012) described how the teacher reduced laptop retrieval and put-away by physically separating her computer carts to reduce aisle crowding by the 6th grade students. Students retrieved the same numbered computer, and she taught them to carry or cradle the laptops like a baby. Some teachers need techniques to recall all students' attention away from their devices for a moment. Strategies tend to involve

Video Example 4.2 Bring Your Own Device (BYOD)

Watch the video and listen to this principal talk about using Bring Your Own Device (BYOD) and other strategies for gaining universal student access to technology. Consider what factors form the rationale for schools and districts using this approach. Listen to this principal's explanation as to why her school district employs this strategy.



an initial physical indicator, such as a clap or a raised hand, followed by all students mimicking the signal. One additional step some teachers use involves students placing their device downward, with the screen facing down on the desk.

GENERAL COMPUTING MANAGEMENT STRATEGIES In addition to specific strategies for special configurations, teachers have developed a range of techniques to help manage the use of technology among students that can be applicable to all arrangements. Some strategies include:

- Preparing instructional handouts (with pictures and/or text) for common computing operations, such as printing, saving, and accessing clip art; laminating the sheets, connecting them on a circle ring, and tethering them to the computer or computing area
- Developing class expectations for computing use in different situations, such as during teacher instruction, student presentations, and collaborative activities
- Using timers as needed to structure equitable access to computer devices
- Hanging headsets/headphones on a hook attached to computers or computing areas
- Teaching students who are having difficulties at the computer to “ask two peers before the teacher” for help

Alignment of Device Configurations with Pedagogical Approaches

Device configurations support different pedagogical approaches as summarized in Table 4.1. We know teachers to be truly inventive, so they should certainly be open to using technological devices in ways that deviate from those described here.

WHOLE-CLASS INSTRUCTION VIA LECTURE OR DEMONSTRATION All device configurations support direct instruction in the form of technology-supported lecture or demonstration assuming that each configuration includes a dedicated device for the presenter and a way to project the technology materials so that all students can see and hear. The presenter could be the teacher, a guest, a student, or a group of students as long as their presentation materials can be easily accessed from the device connected to the projection technology. Sufficient Internet bandwidth and access to video conferencing software such as Skype enable remote guests.

Table 4.1 Device Configurations by Pedagogy

Device Configurations	Pedagogical Approach					
	Whole Class: Lecture or Demonstration	Whole Class: Simultaneous Independent Work	Flipped/Inverted	Centers, Small Group	Collaboration	Independent Work
Innovation station	Yes	No	No	No	No	No
One-Computer classroom	Yes	No	No	Yes	Possibly	Yes
Classroom computers (3–5)	Yes	No	No	Yes	Possibly	Yes
Mobile carts	Yes	Yes	No	Yes	Yes	Yes
Computer laboratories	Yes	Yes	Yes	Possibly	Possibly	Yes
Student-supplied devices	Yes	Possibly	Yes	Yes	Possibly	Yes
School-Supplied devices (1:1)	Yes	Yes	Yes	Yes	Yes	Yes

WHOLE-CLASS SIMULTANEOUS, INDEPENDENT WORK Some teachers plan lessons in which all their students complete independent technology-related activities simultaneously, such as taking a test, practicing or reviewing concepts in tutoring software, researching information online or in library databases, and using software for writing. Mobile carts, computer laboratories, and school-supplied one-to-one device configurations enable this simultaneous, independent work assuming that each student has one device. When they share a mobile cart of devices, teachers need to have access to enough devices for all the students. Student-supplied BYOD configurations might not work for this type of lesson because of inconsistency in software and functionality across the many different types of devices students could have.

FLIPPED OR INVERTED PEDAGOGY Some teaching repertoires include the use of **flipped** or **inverted pedagogy**. Students are required to engage with content concepts, for example via video-based lectures, before coming to class, and then they spend class time in learning activities that help them apply the concepts. These models tend to use online materials for pre-study, so students require access to a computing device and the Internet in most cases to complete their pre-class activities. Therefore, the configurations that afford each student computer and Internet access support flipped pedagogy. If school computer laboratories provide adequate drop-in before or after-school access for all students, then teachers may be able to implement flipped pedagogy. As long as student-supplied or school-supplied devices allowed out-of-class Internet access or the ability to download Internet-specific, pre-study resources while at school for use later, then these configurations can support flipped learning.

CENTERS OR SMALL GROUPS Teachers who have access to a few digital devices, such as three to five classroom computers, often organize student learning with them in a center for small-group activities. Three to five students can work at a technology center while the rest of the class rotates among other centers. These activities should be accomplished independently with explicit instructions provided because the teacher is usually facilitating another center at the same time. For example, five scientific probe-ware devices could be distributed among five small groups of learners to support data collection. Other device configurations, such as mobile carts, BYODs, and one-to-one programs that have up to one device per learner, can be appropriate for center or small group learning activities. In addition, a monitored computer laboratory, such as one in the library, could support centers, but the students would require travel time and would not be near their teacher.

COLLABORATION We distinguish collaborative learning as a situation in which students work together in a structured or unstructured activity with the goal of shared exploration and understanding of knowledge concepts and building a digital artifact that represents such knowledge. Because students are working together, they need access to devices and software that are compatible. Thus, we find that school-supplied devices, such as those in mobile carts or distributed in one-to-one programs, best facilitate collaborative efforts to examine a concept and build a digital artifact, such as a paper, presentation, poster, or video, that represents their development. With fewer devices, such as with one computer, collaborative progress would be slower but still possible.

INDEPENDENT LEARNING A range of pedagogies can be used simultaneously. In some contexts, individual students pursue independent learning activities while other students work in groups or with the rest of the class. Teachers can organize independent learning activities for a range of reasons, including addressing students who have special needs, who need to make up missed work, or others who are pursuing online coursework. All device configurations that allow devices in the hands of students support this pedagogy, but Zheng et al. (2016) noted that one-to-one laptops offer students more control of their learning and teachers more ability to individualize instruction.

Application Exercise 4.2 Device configurations for pedagogy

Productivity Software

Many software tools help teachers and students engage in productivity activities. While many have been in existence for many years, they are constantly being updated with new features, capabilities, and formats. The following section describes key productivity software that might be available in your classroom or school (see Table 4.2).

SOFTWARE SUITES Word processing, spreadsheet, and presentation software is available as a **software suite** for all platforms. Apple developed the iWork suite for use on all Apple computers, iPads, and iPhones; it includes Pages for word processing, Keynote for presentations, and Numbers for spreadsheets. Similarly, Microsoft Office, a software suite for both Macintosh and Windows-based systems, includes Microsoft Word, Microsoft PowerPoint, and Microsoft Excel. G Suite is available as cloud-based software; it includes Google Docs for word processing, Google Slides for presentations, and Google Sheets for spreadsheets.

For teachers who want to create complex print or web publications, Adobe's Creative Cloud offers monthly licenses for access to its suite of high-end desktop and mobile software, such as Adobe InDesign (page design and publishing), Adobe Photoshop (image editor), Adobe Illustrator (graphics and illustration), Adobe Acrobat (portable document software), Adobe Dreamweaver (web design), and Adobe Premier Pro (video editing).

SMART Technologies offers a SMART Learning Suite of tools, including Notebook (lesson creation), Amp (collaborative workspace), Lab (game-based activities), and Response 2 (assessment), that create productivity functionality for SMART Boards.

Table 4.2 Overview of Productivity Software

Productivity Category and Uses	Type of Software Tool or Resource for Productivity
Writing and publishing tools assist in creating pages of text and graphics for communication	<ul style="list-style-type: none"> • Word Processing • Desktop publishing
Representation tools allow the creation of visual, textual, and auditory artifacts for use in presentations, documents, and web pages	<ul style="list-style-type: none"> • Draw/paint software • Image editing software • Media collections • Infographic design software • Presentation software
Data collection and analysis tools make it easier to collect, process, analyze, and visualize data to provide feedback and support decision making	<ul style="list-style-type: none"> • Online surveys software • Spreadsheets • Charting and graphing tools • Visualization software
Planning and organizing tools help organize, plan, and schedule professional and learning activities	<ul style="list-style-type: none"> • Lesson planning software • Scheduling tools • Calendar software • Time management tools • Outlining and concept-mapping software
Instructional material generators allow the creation and use of documents, web pages, lessons, and administrative forms	<ul style="list-style-type: none"> • Web design software • Interactive whiteboard software • Worksheet and puzzle generators • IEP generators • Graphic document makers • PDF and form makers
Assessment tools allow collection and tracking of formative and summative assessment information to measure student progress	<ul style="list-style-type: none"> • Student response systems • Test generators and rubric generators • Computer-based testing systems • Digital portfolios • Gradebooks • Student information systems

OPEN SOURCE SOFTWARE **Open source software** is software whose source code is made available in the public domain and permits users to use, change, improve, and redistribute the software in modified or unmodified form. Apache Open Office and LibreOffice are free, open source productivity suites that offer Writer (word processing), Impress (presentations), Calc (spreadsheets), and software for drawing, databases, and mathematical formula creation. These suites function on Windows, Macintosh, and Linux operating systems. There's also an app for Windows and a LibreOffice Viewer for Android devices. NeoOffice, a low-cost, open source software suite specifically for Macintosh computers is adapted from OpenOffice. Free or low-cost open source software is installed and functions in ways similar to commercial software.

CLOUD-BASED SOFTWARE Some software runs on the Internet via a web browser, which is referred to as **cloud computing**. It eliminates the need for storing data or software on a computer or finding the right software version for a specific computer's operating system. G Suite and Microsoft Office 365 are prominent cloud-based productivity software. Schools have been adopting **Google for Education**, an educational solution that includes devices such as Chromebooks and a cloud-based suite of applications. G Suite, formerly known as Google Apps for Education (GAFE), is offered at no cost and free of advertisements and data-mining only for educators through their schools. G Suite offers:

- Google Classroom—parent communication, assignments, announcements
- Gmail—email
- Google Drive—storage of files
- Google Calendar—scheduling and appointments
- Google Docs—word processing, presentation, spreadsheet applications
- Google Forms—surveys or tests
- Google Sites—website development
- Google Hangouts—video conferencing
- Google Vault—data archival

All of the G Suite apps are accessible through a web browser built on the Chrome operating system on Google Chromebooks, mobile devices, and laptops.

Microsoft Office 365 for Education offers cloud-based productivity apps including Office Online (Word, Excel, PowerPoint, OneNote), Exchange/Outlook (email), SharePoint (website development), OneDrive (file storage), and Yammer (social networking). Because Office 365 also offers local installation that could be on a teacher's computer (determined by the school's account type), it facilitates working without Internet access. Anyone with an .edu email account can obtain Office 365 for Education free from Microsoft.

Many recently developed productivity software programs run as cloud-based or cloud-desktop hybrid applications. For example, Tableau visualization software has a cloud-based software and a downloadable desktop version. **Student information systems (SIS)** can function as cloud-based software or run on internal school servers (although the end user would not notice a difference). Many planning, organizing, and instructional materials are generated through cloud-based software, which create web-based or downloadable artifacts, such as a calendar, for use by teachers.

Video Example 4.3 How Google Apps Work

Watch the video which explains how Google Apps use cloud computing.

<https://youtu.be/doHnLIAzQ5M>

MOBILE SOFTWARE Handheld devices such as tablets, mobile phones, and laptops have made computing even more portable and accessible to teachers and students. All of these software suites discussed previously in some form are available on tablets and handheld devices. iWork's Pages, Numbers, and Keynote (and iMovie and GarageBand) apps are available for download at no cost on qualifying devices. iWork for iCloud allows users with an iCloud account to use these apps via the Safari, Chrome, and Internet Explorer web browsers on any device. A feature allows real-time collaborative editing of files. Open source software such as OpenOffice and LibreOffice offer apps that allow document viewing. G Suite is installed at no cost on all Google Chromebooks and functions natively in the Chrome operating system (ChromeOS). G Suite can be accessed through downloadable mobile apps for iPad, iPhone, iPod, Android devices, and Windows devices or through a web browser. Microsoft Office 365 can be accessed through web browsers on any device and via mobile apps for Windows, Apple (iOS), and Android devices.

DESKTOP SOFTWARE Although most new software is being developed for cloud-based use via any device, some older or more complex software functions as stand-alone software a user installs on a computer. For example, the SMART Learning Suite is downloaded and installed on a computer through which teachers can create lessons or assessments for use on their SMART Board. Some software previously described in software suites, such as Microsoft Word and PowerPoint, have desktop versions that can be installed on computers. Installing new desktop software in a school typically requires administrative access to the computing device, which teachers often do not have, so they must request technical assistance.

FILE EXCHANGE COMPATIBILITY Even when different schools (or even classrooms) adopt different software and devices, today's software tools – computer, app, and cloud-based – are designed to be compatible across software and **computer platforms** or types of computer operating systems (e.g., Macintosh versus Windows), making transfer of documents and collaboration on projects much easier for teachers and students. Most of the **files**, or products created in one program, can be exchanged with people using other software or devices. In some cases, files created in one program, such as a Macintosh version of Microsoft Word, can be seamlessly exchanged and opened in a Windows version. All software allows exporting or saving as a different file type. For example, G Suite users could download a copy of their Google Sheet as an Excel spreadsheet, an **OpenDocument format (ODF)** document, a web page, or a **portable document format (PDF)**. iWork users could export their Keynote presentation as a PowerPoint or a PDF document. In some instances, a file might not retain all its formatting features exactly the way they were designed in the original software, so users should always check through a new file before submitting it as final when turning it in for an assignment or using it for a presentation to a group.



Check Your Understanding 4.1

Writing and Publishing Software for Teaching and Learning

Most written documents and some digital products such as digital books are created with word processors and desktop publishing software. **Word processing** software allows the production and revision of text-based information as well as the addition of

Table 4.3 Writing and Publishing Software and Functions

Software Tool	Example Software	Software Function	Sample Products
Word processing	<ul style="list-style-type: none"> • Microsoft Word • Google Docs • Pages • OpenOffice Writer 	Creates documents consisting of pages with text, graphics, tables, charts	Teacher —Newsletters, letters, and lesson plans Students —Compositions, poetry, reports, flyers, and book reports
Desktop publishing	<ul style="list-style-type: none"> • Microsoft Publisher • Adobe InDesign • Canva • iBooks Author • Book Creator • QuarkXpress 	Creates publishable print or digital content using graphic design, content editing and layout, and production	Teacher and students —Letterhead, brochures, flyers/posters, newsletters, newspapers, and books

many kinds of graphics, tables, and other features to text products. Perhaps no other technology resource has had as great an impact on education as word processing.

Desktop publishing, a term coined in 1984 by Paul Brainerd, founder of the Aldus Corporation, uses a combination of software, computers, and printers to control the form and appearance of content and to allow individuals to be their own publishers. Most desktop publishing software now supports design for print and digital layout of content, which can support creation of apps, ebooks, or digital magazines and newspapers. Table 4.3 identifies various software programs, their functions, and the products that teachers and students can make with them.

Desktop publishing software is designed to create documents that have separate pages linked as an entire product. Pages can be viewed separately and as part of a complete layout. The software provides flexibility and precision in the placement and format of both text and graphics on individual pages. In contrast, text and graphics in word-processed documents “flows” in a continuous stream, which makes precise placement of text and graphics difficult if new content is added.

Teachers and school staff can use any available word processing software package to create most of the desktop publishing products for a school environment (e.g., classroom brochures and newsletters). The more advanced layout features offered by desktop publishing software (e.g., elaborate layering of text and graphics elements) are needed only if teachers are developing or teaching students how to design and lay out large, complex documents such as newspapers, yearbooks, and books. Some teachers have begun writing and producing their own textbooks collaboratively with their colleagues or students. A fifth grade teacher worked with her students to publish science-related ebooks using iBooks (Encheff, 2013).

Integration Strategies for Writing and Publishing Software

Both teachers and learners use writing and publishing software. Teachers tend to create documents for instruction and administrative tasks. Learners write and publish to represent their developing knowledge across all discipline areas. Table 4.4 describes common features and benefits of this software.

TEACHER USE OF WRITING AND PUBLISHING SOFTWARE Word processing and desktop publishing offer many general **relative advantages** (unique benefits over other methods) for teacher productivity:

- **Saves time**—They help teachers use preparation time more efficiently by letting them modify materials instead of creating new ones. Writers can make corrections to digital documents more quickly than they could on a typewriter or by hand.
- **Enhances document appearance**—Materials look more polished and professional than handwritten materials. The use of many software templates makes this possible.

Table 4.4 Features of Writing and Publishing Software

Software and General Benefits	Common Features
<p>Writing software—Saves time writing text; makes changes easier and more flexible</p>	<p>Formatting—Change alignment, margins, fonts, type size, colors, line spacing, shading, borders; set headers, footers, watermark</p> <p>Graphics and interactivity—Add graphics, shapes, callouts, tables, charts, text boxes, live URLs</p> <p>Templates—Use preformatted models of resumes, newsletters, brochures</p> <p>Language—Use spelling and grammar check, thesaurus; sets custom language</p> <p>Voice typing and speech—Enter oral text; read words as typed</p> <p>Mail merge—Create document template with fields; merge data from spreadsheet into preset fields</p> <p>Export—Publish to web; save as PDF, Rich Text Format (RTF), and graphic files</p>
<p>Desktop publishing—Creates professional-quality products that combine text and graphics</p>	<p>Precise page layout—Use master layout, frames, ruler for precise and consistent placement of all content elements</p> <p>Template—Create documents produced by professionals for use as guide for specific design tasks</p> <p>Style sheets—Set a format and repeat it throughout a document as needed</p> <p>Customized graphics—Adjust size, rotate, flip, zoom, stroke, fill, arrange, group/ungroup, transform; add lines and shapes</p> <p>Seamless integration—Import files from other programs</p>

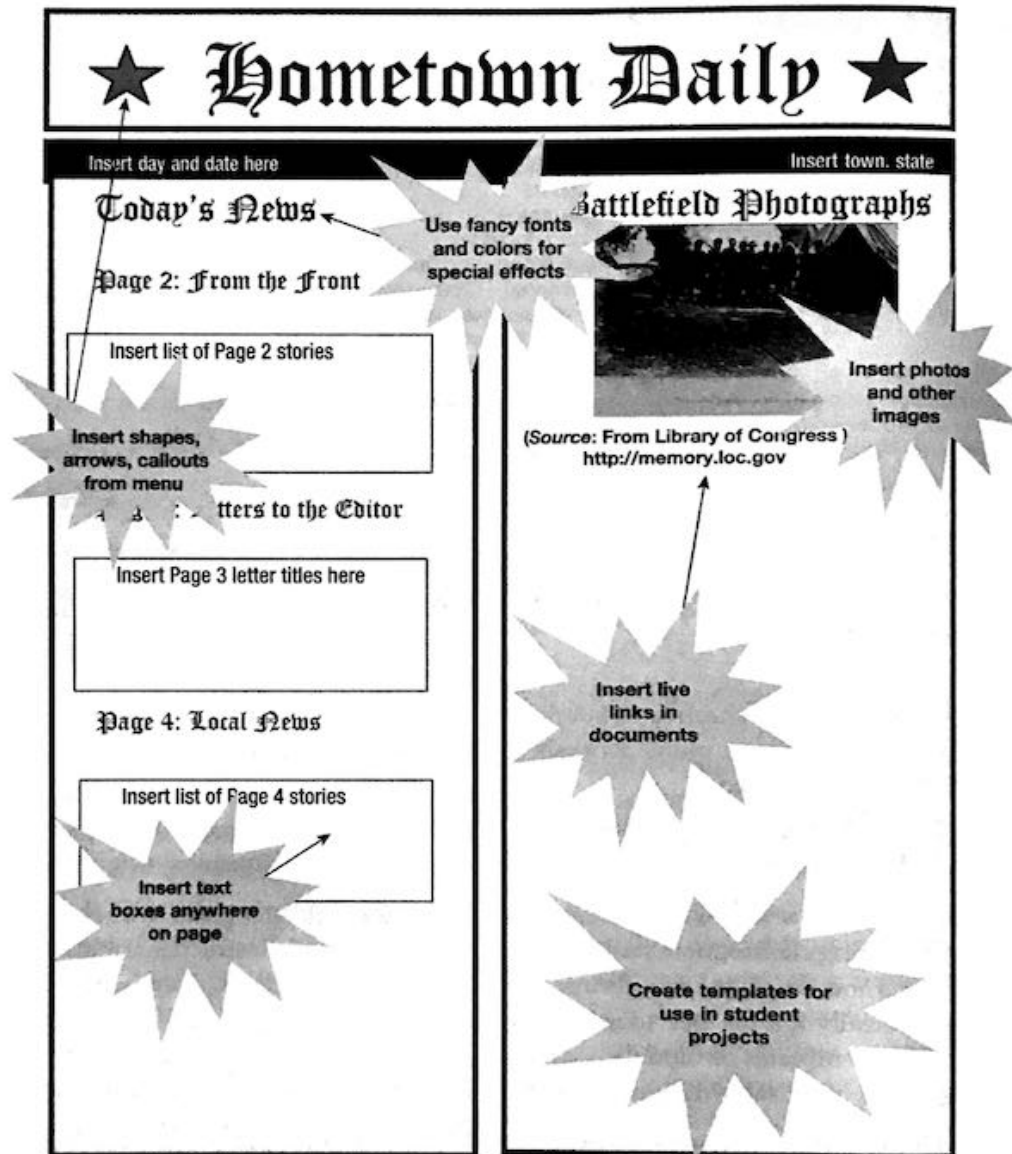
- **Allows document sharing**—Materials can be shared easily among writers. Teachers can exchange lesson plans, worksheets, and other materials and modify them to fit their specific needs.
- **Allows collaboration on documents**—Especially since the release of products such as Google Docs, teachers can now create, edit, and share documents synchronously.

As noted in the list, word processing and desktop publishing can save teachers time in preparing classroom materials such as handouts or other instructional materials, lesson plans and notes, reports, forms, letters to parents or students, flyers, and newsletters, especially if a teacher adapts the same documents every year. Teachers might want to keep templates or model documents they can easily update and reuse. The following is a list of reusable digital documents that teachers might want to have available.

- Beginning-of-year welcome letter
- Name tags
- Permission letter for field trips and other events
- Flyers and other announcements
- Request for fee payments letter (e.g., for field trip)
- Fund-raising letter
- Class rules poster
- Letterhead template
- Periodic student progress letter for parents
- Lesson plans and instructional notes
- Student information sheets and handouts
- Newsletters
- Annual reports required by the school
- Frequently used worksheets and exercises

A sample word-processed template like the one in Figure 4.2 was created for a history lesson to engage students in events of the Civil War. Using information that students learn in class and obtain online, they create a “daily newspaper” as it might

Figure 4.2 Sample Template with Highlighted Word Processing Features



have appeared during the Civil War. It is filled with descriptions of battles and local events. The most productive word processing features used to create this template are labeled in the figure.

Cloud-based word processors, such as Google Docs, might not have the breadth of formatting features as compared with Microsoft Office, but their online accessibility and real-time collaboration with multiple users offers teachers many affordances. Cloud-based word processing features support teacher productivity by allowing them to:

- Share files and collaborate synchronously for
 - Lesson planning with colleagues
 - Staff/Grade-level meeting notes (written by and/or shared with everyone at close of meeting)
 - Curricular lesson repository (e.g., staff share a folder of their lesson plans on an institutional Google account)
 - Handouts to distribute to students and/or teacher monitoring of students' progress
- Publish documents on the web

- Translate materials in different languages (we advise checking the results with a native speaker prior to distribution)
- Easily add equations to handouts by using Add-on *g(Math)*
- Provide student feedback orally using Add-on *Kaizena* (only appropriate for students without hearing impairments)
- Highlight information and make comments to provide formative feedback without paper or digital file submission
- Monitor student contributions and progress with the revision history in each document

STUDENT USE OF WRITING AND PUBLISHING SOFTWARE Students can also use word processing and desktop publishing software for producing a range of digital products. Engaging in writing with word processing cannot improve the quality of student writing but can help students make corrections more efficiently; this can motivate them to write more and take more interest in improving their written work. Desktop publishing is the strategy of choice to produce elaborate, graphic-oriented documents (e.g., flyers and posters, brochures, newsletters and magazines, and books and booklets) and can boost student's self-esteem when they publish their own work, heighten interest in writing and increase motivation to write for audiences outside the classroom, develop language skills, and improve learning through small group collaboration. A list of common classroom projects and ideas for implementing word processing and desktop publishing follows:

- **Projects supporting writing processes**—Students can use word processing and desktop publishing to write, edit, and illustrate stories, to produce reports in content areas, to keep notes and logs on classroom activities, and for any written assignment. Using word processing in the classroom can make it easier for students to get started writing and to revise and improve their writing. Teachers and students can make good use of the **track changes** feature in Microsoft Word, which allows readers to edit written work, which appears as colored text, to guide revision. Teachers and students can also use **comment boxes** that allows inserting written notes in margins. Google Docs also includes an editing and suggesting mode. AbuSeileek (2013) found that students who received corrective feedback using such features were more likely to eliminate targeted writing errors (e.g., sentence fragments and run-ons) than those who did not.
- **Projects using a dynamic group product approach**—Teachers can assign group poems or letters to various students, allowing them to add and change lines or produce elements of the whole document in a word processing program. The use of such programs facilitates sharing and collaboration, and students find it easier to share, exchange, and contribute to drafts. Students also work together on written projects at a distance. Ullman (2013) described several strategies that schools are using to connect students around the globe and to engage them in collaborative document projects in ways that accomplish Common Core State Standards in writing and language.
- **Projects assigning individual language, writing, and reading exercises**—Specific word processing exercises allow for meaningful, hands-on practice in language use as individual students work to combine sentences; add, delete, or correct punctuation; or write sentences for spelling words. Word processing can also make possible a variety of reading/language-related activities ranging from decoding to writing poetry and enjoying literature. Identifying and correcting errors becomes a visual process.

Technology Integration

Example 4.1

TITLE: The Language of Jazz—An Integral Part of American History and Culture

CONTENT AREA/TOPIC: Music/History

GRADE LEVELS: Elementary to middle school

ISTE STANDARDS•S: Standard 1—Empowered Learner; Standard 3—Knowledge Constructor; Standard 6—Creative Communicator

CCSS: CCSS.ELA-LITERACY.RH.6-8.1, CSS.ELA-LITERACY.RH.6-8.4, CCSS.ELA-LITERACY.RH.6-8.8

DESCRIPTION: Students use the web to research the history of jazz and the life of one jazz musician and his or her effect on American culture. Then they use word processing software to create a brochure about the musician and share it with the class.

SOURCE: Based on a concept in a lesson plan from Microsoft Education collection.

- **Projects encouraging writing across the curriculum**—Writing across the curriculum emphasizes integrated, interdisciplinary, and thematic curricula by encouraging writing skills in courses and activities other than those designed to teach English and language arts. Word processing and desktop publishing can encourage these integrated activities. Font and graphic features allow students to represent concepts in mathematics, science, and other content areas. Word processors are also available in other languages to support foreign language learning. The Technology Integration Example 4.1 illustrates the use of word processing to write across the curriculum.
- **Projects supporting student writing and language learning**—Adaptive keyboard and voice recognition capabilities make writing more accessible for students with physical challenges. Word processors also have optional features that support writing in many languages, complete with appropriate spell-checking and diacritical marks. The Adapting for Special Needs feature box reviews productivity software that can assist students with special needs.
- **Projects providing methods to report research findings**—Popular ways to use desktop publishing to report on students' research include creating travel

Box 4.1

Adapting for Special Needs: Digital Writing Tools

Word processing skills are expected of all students across all subjects and grades. However, some students have difficulty with this task because of physical, sensory, or cognitive impairments that interfere with written expression. To support all writers, educators can use tools like the following that encourage written expression for diverse learners:

- **Clicker (Crick Software)**—A word processor that lets students click on letters, words, or short phrases so they can write sentences without using the keyboard. It is ideal for students with autism, intellectual disabilities, and learning disabilities because of the visual supports.
- **Co:Writer (Don Johnston)**—A word prediction program that helps students who have illegible handwriting, poor

phonetic spelling, or a physical disability that makes typing difficult or have difficulty translating thoughts into writing. It is ideal for students with learning disabilities and physical disabilities. It works in conjunction with other word processing software.

- **Picture It (SunCastle Technology)**—Allows teachers to create picture-assisted reading materials to help readers and writers. It is ideal for young children, second language learners, and students with intellectual disabilities.
- **Scholastic Keys (Tom Snyder, Inc.)**—Gives elementary students an early introduction to using Microsoft Office by providing a kid-friendly interface for Word, Excel, and PowerPoint. It is ideal for young children, second language learners, and students with intellectual disabilities.

—Contributed by Dave Edyburn

Technology Integration

Example 4.2

TITLE: Mystery Writers!

CONTENT AREA/TOPIC: Language arts, creative writing

GRADE LEVELS: 3–5

ISTE STANDARDS•S: Standard 1—Empowered Learner; Standard 6—Creative Communicator

CCSS: CCSS.ELA-LITERACY.RL.3.3, CCSS.ELA-LITERACY.W.3.3, CCSS.ELA-LITERACY.W.3.6, CCSS.ELA-LITERACY.W.4.3.D, CCSS.ELA-LITERACY.W.4.10, CCSS.ELA-LITERACY.RL.5.9, CCSS.ELA-LITERACY.W.5.3.A

DESCRIPTION: Students assume the identity of private investigators as they read, solve, and write mysteries in order to learn about the genre and encourage creative writing. The teacher helps students outline the critical elements of a mystery story and allows them to map a sample mystery to illustrate these elements and a story line. Then the teacher introduces nursery rhymes as mystery story starters (e.g., Why did Humpty Dumpty fall off that wall? How did Mother Hubbard's cupboard become empty?). Students organize their stories with sticky-note story maps or outlines, then word process their stories, and complete drafts with teacher feedback.

SOURCE: Based on a concept in an EducationWorld.com lesson

brochures that report on student exploration during field trips, descriptions of the local region, and information about organizations or activities. Sometimes this type of activity represents the culmination of a large project, such as a series of science experiments or a social studies research unit; sometimes it is a way for every student to contribute writing to a class project. All of these projects are highly motivational to students.

- **Projects offering opportunities for creative works**—Even very young students are thrilled to produce and display their own personal books, which sometimes represent work produced over the course of a school year. Sometimes the books show creative works resulting from a competition; frequently, examples of students' best work are collected for a particular topic or time period, and students can sell their publications as a fund-raising activity. Projects such as these reap benefits for students of all abilities. Teachers report that "getting published" increases students' pride in their work and makes them want to spend more time on it (Encheff, 2013).

Word processing not only offers great versatility and flexibility but also reflects no particular instructional approach. A teacher can use it to support any directed instruction or constructivist activity. In the following Technology Integration Example 4.2, a teacher combines modeling (reading mysteries), teaching structure (mystery genre), and writing process with word processing.

Instructional Strategies for Writing and Publishing Software

Students new to word processing and desktop publishing must have adequate time to develop skills in using the software before creating products. Some schools have technology or business teachers who teach students these skills. Classroom teachers should coordinate with these teachers to ensure that their students have the needed skills prior to a lesson involving word processing or desktop publishing or should be prepared to teach the required skills. Online tutorials are available for teaching various software packages, and some teachers create their own video tutorials, but these can serve best as supplementary learning sources because not all learners have the ability to learn by using self-instructional methods. Teachers who would like to use writing or publishing software in classroom lessons might have to introduce their students to

the features and uses of the software. Table 4.5 shows a general sequence for introducing software to students in the classroom. Teachers should review the features of word processing and desktop publishing as summarized earlier in Table 4.4 to guide their instruction for students.

Word processed and desktop published products have increased impact and communicate the author's intent more clearly if they reflect some fairly simple and effective design criteria. These include:

- **Use a limited number of typefaces (fonts)**—Unusual typefaces or fonts can help direct the eye toward text, but too many different fonts on a page can be distracting, and some fancy fonts are difficult to read.
- **Use a different font for title and text**—To aid the reader, use a **serif typeface** (one with small curves or “hands and feet” that extend from the ends of the letters) for text in the main body of the document. Use a **sans serif typeface**, a font without extensions, for titles and headlines.
- **Use appropriate sizes for type**—Make the type large enough to be read easily (e.g., younger readers usually need large point sizes) but not too large to dominate the page.
- **Avoid overuse of type styles**—Breaking up text with too many font styles interferes with reading. Avoid excessive underlining, boldfacing, and italics.
- **Match text and background colors**—Use white or yellow type on a black block to add drama. Avoid color combinations that can be difficult to read (e.g., orange on green or red on blue).

Table 4.5 Strategies for Teaching Software Use to Students

Suggested Steps	Tasks for Each Step
Step 1 —Prepare for teaching	<p>Arrange for—</p> <ul style="list-style-type: none"> • A big screen and projection system or interactive whiteboard (IWB) • A flash drive or a cloud-based storage location for each student • Sample file(s) to be copied onto network or student storage • One computing device per student if possible • Alternative keyboards or other adaptive devices for students with disabilities <p>Create or obtain—</p> <ul style="list-style-type: none"> • Handouts or wall posters on key software features and common errors
Step 2 —Demonstrate the basics	<p>Using a big screen and projection system or IWB, show how to—</p> <ul style="list-style-type: none"> • Transfer a document to a computing device (if needed) • Open, name, and save a document • Move around in a document using the cursor and scroll bars • Add and delete content to the document; undo changes made • Close a document <p>Point out common errors</p>
Step 3 —Assign individual practice	<p>Give students a sample document file and have them—</p> <ul style="list-style-type: none"> • Open, save as, and name it • Complete a list of changes to it • Save and close it
Step 4 —Demonstrate advanced features	<p>Using a big screen and projection system or IWB, show—</p> <ul style="list-style-type: none"> • Advanced features of the software <p>Point out common errors</p>
Step 5 —Assign more individual practice	<p>Have students open their sample file from Step 3 and have them—</p> <ul style="list-style-type: none"> • Engage with selected advanced features demonstrated in Step 4
Step 6 —Demonstrate procedures with new files	<p>Show students how to—</p> <ul style="list-style-type: none"> • Open a new file • Name and save the file under different names (save vs. save as)
Step 7 —Assign more individual practice	<p>Do the following:</p> <ul style="list-style-type: none"> • Assign a product for students to copy (for younger students) or create (for older students) • Monitor students as they work and give individual help as needed

- **Use visual cues**—Attract reader attention to important information on the page by using frames or boxes around text, bullets or arrows to designate important points, shading of the part of the page behind important text, different text styles (e.g., boldface or italic type), and captions for pictures and diagrams.
- **Use white space well**—There is a saying in advertising that “white space sells.” Don’t be afraid to leave areas in a document with nothing in them at all to help focus attention on areas that do contain information.
- **Create and use graphics carefully**—Use pictures and designs to focus attention and convey information, but remember that too many elaborate pictures or graphic design elements can be distracting.
- **Avoid common text format errors**—Common design pitfalls include using irregularly shaped text blocks and angled type, both of which are difficult to read.
- **Avoid common text break errors**—Use desktop publishing software features to control for widows and orphans (leftover single words and phrases at the tops or bottoms of pages) and excessive hyphenation.

Benefits of Writing and Publishing Software

Research indicates that word processing can improve aspects of the writing process and attitudes toward writing only if it is used in the context of good writing instruction and if students have enough time to learn word processing procedures before beginning their work. Several meta-analyses, which represent hundreds of studies (Bangert-Drowns, 1993; Goldberg, Russell, & Cook, 2003; Hawisher, 1989; Morphy & Graham, 2012; Snyder, 1993; Zheng et al., 2016), indicate that students who use word processing showed better writing quality, more writing, fewer mechanical errors, increased engagement in revision, and more frequent publishing of their work. Some studies identified better attitudes toward writing. However, use of word processing is not a magic cure-all; a study by Graham and Perrin (2007) showed that word processing had a positive impact on students’ skills in sentence construction, inquiry, prewriting activities, and process approaches but found that the instructional techniques of strategy instruction, summarization, peer assistance, and setting product goals had more impact on students’ writing skills. Thus, teachers must integrate optimal writing strategy instruction with the use of word processing for maximal impact. Dave and

Video Example 4.4 Using Word Processing to Support Writing and Revising

In this video, a principal tells how word processing supports writing processes.



Russell (2010) note that most revisions primarily concern surface-level corrections, such as spelling and grammatical errors, and word processors seem to have had limited effect on promoting global revision or overall improvements in depth and quality of written communication. Thus, using a word processor likely will not change a students' perception of writing without a teacher explicitly teaching and emphasizing global revision as a process. Some research indicates that weaker writers' writing quality benefits more from word processing use than stronger writers (Morphy & Graham, 2012).

Many veteran and novice teachers (Hughes, 2013; Quimbo, 2011) report more limited experience with desktop publishing than with word processing, which can hamper their commitment to use it with students. No research studies have examined the effect of teachers' or students' use of desktop publishing, but examples of teacher use portray highly motivational, authentic projects. For example, Ash (2011) describes students in eighth grade or beyond who interviewed and photographed people to contribute to published books created in QuarkXPress desktop publishing. The students published and sold books about Wisconsin women and another on Holocaust survivors as part of an oral history project.

Challenges of Using Writing and Publishing Software

Educators seem to agree that although the use of writing and publishing software is valuable, its use in education can be controversial regarding the following:

- **The age at which students should start word processing**—Word processing software designed for young children is available, and schools can introduce it to students as young as 4 or 5 years old (Dinehart, 2015). Some educators feel that word processing will free students from the physical constraints of handwriting, allowing them to develop written expression skills. Others worry that it will make students unwilling to spend time developing handwriting abilities and other activities requiring fine-motor skills. Dinehart (2015) indicates that Common Core State Standards (CCSS) encourage students in first grade to use digital tools to write.
- **The need to teach keyboarding skills**—Discussion is ongoing about whether students need to learn keyboarding (“10-finger typing” on the computer) either prior to or in conjunction with word processing activities. Some recommend teaching keyboarding to children 10 years of age because their hand span is wide enough for keyboards (Armstrong, 2014), and the CCSS expect that by grade 4, students can type one page in one sitting (Poole & Preciado, 2016). Some educators feel that students will never become really productive on the computer until they learn 10-finger keyboarding and that keyboarding ability influences writing quality. Other educators feel that they do not have time to teach keyboarding instruction given the heavy demands of addressing curriculum standards (Poole & Preciado, 2016).
- **The effects of word processing on handwriting**—Although no researchers have conducted formal studies of the impact of frequent word processing use on handwriting legibility, computer users commonly complain that their handwriting isn't what it used to be, ostensibly because of infrequent opportunities to use their handwriting skills. In addition, cursive writing, long a staple in elementary school curriculum, is not included in the CCSS (Supon, 2009; Wollscheid, Sjaastad, Tømte, & Løver, 2016). Debate still swirls, however, around the question of whether typing should replace cursive writing (Vacek & Fuhrhop, 2013). Recent studies indicate that cursive writing exercises fine-motor control skills and activates multiple areas of the brain that contribute to self-regulation and executive functioning in ways that typing does not (Armstrong, 2014; Dinehart, 2015).
- **The impact of word processing on assessment**—Some organizations have students choose between word processing and handwritten formats for answering

essay-type test questions, but there is an increasing tendency toward requiring students to take all tests on a computer. This practice introduces several issues. First, some researchers have found that essay graders tend to discriminate against word-processed papers, consistently giving them lower scores than handwritten ones (Mogey, Paterson, Burk, & Purcell, 2010). Educational institutions that allow students to choose either handwriting or word processing must be careful to establish guidelines and special training to ensure that raters do not inadvertently discriminate against students who choose word processing. Second, schools that require word processed writing for tests must ensure that students are experienced enough with the software so that a lack of word processing skill does not affect the quality or quantity of their written expression.

- **The introduction of inadvertent errors**—Link (2009) warned that the autocorrection software feature built into most word processors can replace typed words with ones that the feature selects as being more correct, leading to changes that interfere with intended meaning. Teachers and students must be aware of this built-in feature and either turn it off or carefully consider suggestions and proofread.

Teachers and administrators are still deciding how best to deal with these enduring quandaries. Nonetheless, an increasing number of teachers and students depend on writing software, and the awareness of the value of desktop publishing is growing.



Check Your Understanding 4.2

Representation Software for Teaching and Learning

Teachers and students often need to represent concepts to others whether it is instruction in content concepts or demonstration of students' developed knowledge. Representing concepts, ideas, and knowledge can be done by speaking, describing, illustrating, and performing. Various tools help teachers and students create graphics, symbols, text, and audio or video to depict, illustrate, or demonstrate concepts. Representation tools include software for drawing or painting, image editing, making multimedia productions, and creating infographics and presentations. Table 4.6 summarizes functions and representation products that can be created with the example software.

Drawing and painting software tools help users create their own graphics to insert into any digital products or web pages. In simpler draw/paint programs, such as Kid Pix, users select graphics components (e.g., colors, shapes, lines) from menus and toolbars to create an image in a matter of minutes. Higher-end programs, such as Adobe Illustrator, make creating complex drawings possible but require knowledge of art and graphic techniques. SketchUp facilitates drawing 3-D content; such programs are usually used in high school-level communications and technology education courses. Figure 4.3 shows a secondary-level student developing original artwork on screen.

Image editing programs allow modification of any graphical image. This software is often used to enhance and format photos that are later imported to other software such as desktop publishing to create presentations or web pages. Image editing programs such as Adobe Photoshop are known for their sophistication and wide-ranging capabilities and can require considerable time to become familiar with all their facets, but new tools such as Instagram, Hipstamatic, and Snapseed, which work on mobile devices, make image editing more accessible. Gran (2013) writes about these tools primarily from the standpoint of teaching photography and the arts, but image editing can also be used in all subject areas.

Figure 4.3 Sample Draw/Paint Software at Secondary Level
(Photo by W. Wiencke)



Downloading images from the web is easy, but remember that most images found on web pages are copyrighted. Their legal use is determined by applicable copyright law and the owner of the image or the website. Teachers who are not sure whether they can use the media legally should contact the website owner to request permission. After determining that they have rights to use the media, teachers can use a browser to download it and store it on their computer; most often inserting it in documents or other web pages by right-clicking and selecting "Save Image As." Several **image formats**, or ways of storing images, have been developed over the years to serve various purposes. The suffix in an image's filename identifies its format. The most common formats are:

- **GIF**, which stands for *graphics interchange format*, is used for drawn images, illustrations, clip art, and animations.
- **JPG**, shortened from JPEG, which stands for *joint photographic experts group*, is used for photographs.

Images downloaded from web pages will most commonly be in JPEG format. JPEG or GIF format can be used to add images on users' own web pages. Users who want to change an image to one of these formats need to bring it into an image manipulation program (e.g., Adobe Photoshop) and then save it in either GIF or JPEG format.

When users cannot create original graphics, they turn to web-based **media collections** that include fonts, clip art, drawings, cartoons, photos, animations, sounds, or videos that are copyright free or available at a modest cost. For example, high-quality photos, illustrations, and videos can be found at sites listed in Table 4.6. Most word processing, presentation, desktop publishing, image editing, and draw/paint programs can import these media.

Infographic software allows users to create a visual representation of information or data that aids in communicating, learning, and understanding content. Infographics tend to visually highlight patterns in data, such as frequency of words using word clouds, numerical patterns in charts, and chronology in timelines. Although infographic software can be designed in desktop publishing or image software, the specialized infographic software summarized in Table 4.6 makes the process far simpler.

Presentation software is designed to display information, including text, images, audio, and video, that often includes sequencing. Many presentation tools such as Microsoft PowerPoint and Google Slides are slide based and some, such as Pear Deck, have live, interactive student polling features. A user creates slides or frames that can

Category	Example Software
Draw/Paint Software	<ul style="list-style-type: none"> • Adobe Illustrator • Krita • TuxPaint • Krita • SketchUp • Google Draw
Image Editors	<ul style="list-style-type: none"> • Adobe Photoshop • Google Nik • GIMP • Instagram
Media Collections	<ul style="list-style-type: none"> • Freepik • Stock Photo • Classroom C • Public Domain • Google LIFE • AudioMicro • Adobe Fonts • Animation Fe • Getty Images
Infographic Software	<ul style="list-style-type: none"> • Piktochart • Canva Infogr • Venngage • Dify • Infogram • Google Char • Tableau Publ • Wordle • Taggedo
Presentation Software	<ul style="list-style-type: none"> • Microsoft Pow • Google Slides • Keynote • OpenOffice i • Prezi • PowToon • Pear Deck

be presented sequentially or in any order using nonlinear tools like Prezi or a

Integration Strategies for

Representations often are harnessed to present information to listeners or students. The available representation software tools as in the various features summarized in Table 4.6 offer the following benefits:

TEACHER USE OF REPRESENTATION

- **Enhance the impact of spoken content.** Designed, it supports and supplements audio and multimedia to give illustrations and visual, textual, and auditory representations of complex or difficult concepts or difficult-to-understand information.
- **Enable multimedia-rich content.** A speech teacher, described how the importance of repetition, style, and content can be emphasized through original or downloaded, other varied representations.

Table 4.6 Representation Software Tools, Functions, and Products

Software Tool	Example Software	Software Function	Sample Product
Draw/Paint software	<ul style="list-style-type: none"> • Adobe Illustrator • KidPix • TuxPaint • Krita • SketchUp • Google Drawings 	Draw, paint original artwork	Teacher and students: Visual representations of content concepts
Image editors	<ul style="list-style-type: none"> • Adobe Photoshop • Google Nik Collection • GIMP • Instagram 	Create, modify, combine any images, such as photographs, clip art, line drawings	Teacher and students: Visual representations of content concepts
Media collections	<ul style="list-style-type: none"> • Freepik • iStock Photos • Classroom Clipart • Public Domain Clip Art / Photos • Google LIFE • AudioMicro • Adobe Fonts Folio Education • Animation Factory • Getty Images Footage 	Download fonts, clip art, drawings, cartoons, photos, animations, sound, video (may charge a fee for use)	Teacher and students: Audio or visual representations of content concepts
Infographic software	<ul style="list-style-type: none"> • Piktochart • Canva Infographic Maker • Venngage • Dipity • Infogram • Google Chart Tools • Tableau Public • Wordle • Tagxedo 	Create graphical visual representations of multimedia information or data to improve understanding of trends or patterns	Teacher and students: Timelines, charts, maps, data visualization
Presentation software	<ul style="list-style-type: none"> • Microsoft PowerPoint • Google Slides • Keynote • OpenOffice Impress • Prezi • PowToon • Pear Deck 	Combine, order, and display text, graphics, animations, audio, video in an automated or untimed presentation	Teacher: Demonstrations and support for lectures, tutorials, representations or animations of content concept Students: Support for oral reports, animated hypertextual books

be presented sequentially or in any order the user sets. Teachers and students are also using nonlinear tools like Prezi or animation tools like PowToon or GoAnimate.

Integration Strategies for Representation Software

Representations often are harnessed to support speakers (teachers and students) as they present information to listeners or share information in print or web-based products. The available representation software provides multipurpose teaching and learning tools as in the various features summarized in Table 4.7.

TEACHER USE OF REPRESENTATIONS Teachers use representations because they offer the following benefits:

- **Enhance the impact of spoken information**—When a representation is well designed, it supports and supplements what the teacher says by using graphics and multimedia to give illustrations and emphasize points with images and sound.
- **Enable multimedia-rich content representations**—Teachers can build or integrate visual, textual, and auditory representations of content concepts that target common misconceptions or difficult areas of the curriculum. For example, Perry (2012), a speech teacher, described how she used word clouds to help students understand the importance of repetition, style, and focus in their speeches.
- **Help make content more polished and professional**—Media artifacts, whether original or downloaded, offer valuable resources that help illustrate and build polished representations.

Table 4.7 Features of Representation Software

Representation Software/General Benefits	Description of Common Features
Draw/paint —Assist in designing and drawing visual images	Autoshape —Add shapes, blocks, arrows, call-outs, stars, flowcharts, text Paint —Add 3-D effects, shadows, transparency, textures, gradients Layer —Build an image with layers, each of which can be independently altered Customization —Choose line style, thickness, brushes, arrowhead ends, patterns, colors, fill effects, rotation, flip Clip art and template —Start with template design and add clip art, cartoon stamps Exportable —Save as a range of graphic file formats
Image editing —Allow users to edit and manipulate images, pictures, photographs, other graphic files	Image enhancement —Correct color hue, brightness, red eye, sharpness, contrast, zoom, size, cropping Selection —Manipulate parts (as small as the pixel) or a whole image Layer —Build an image with layers, each of which can be independently altered Image change —Remove elements, change color, rotate or flip, sharpen or blur, merge images, add special effects Export —Save as a range of graphic file formats
Media collections —Provide online access to image, audio, video resources	Browse, watch, listen, or download —View or download media resources for use Embed —Provide easy embed codes for resources for use in web-based products or learning tools interoperability (LTI) integration with learning management systems Playlist —Allow users to create custom playlists of resources Usage rights —Check usage rights (e.g., public domain, Creative Commons, or copyrighted) prior to use
Infographics —Allow users with non-design backgrounds to design and create data-based messages	Infographic template —Start a project by choosing a design template that matches needs of message Chart and graph template —Using numerical data, choose appropriate charts or graphs to input data or use built-in software spreadsheet to build data and then chart or graph it Pictogram maker —Build visual representations of data that use icons and colors to represent patterns Ready-made images and icons —Use copyright-free images or icons to build visual aspects of infographics Image editing —Allow limited editing of user's or built-in software's images Customization —Add colors, fonts, layout of elements Exportable —Publish to web or export as PDF, graphic files
Presentation —Allows display of information in a defined sequence or layout	Organization of information —Use frames or slides for information units with sequencing, customized layouts Formatting —Allow text variation in font, size, frame background Graphics and interactivity —Insert images, clip art, shapes, videos, animations, charts, graphs, buttons, live URLs Templates —Add information to already formatted files that come with themed graphics already on each slide Audience viewing option —Provide modes for presenter-controlled viewing, autoplaying presentations for independent viewing, publishing to a website, exporting in various formats (e.g., PDF, ODP, JPG), or print Oral presentation support —Add speaker notes to slides played as each frame is presented

- **Help organize thinking about a topic**—When teachers create a presentation, it helps them think through what they will say and in what order they should present information. Although using infographic or presentation software does not ensure an organized, coherent message, its emphasis on sequencing and breaking information into component parts can promote a more organized approach. Using presentation software also allows teachers to model information organization skills.
- **Serve as enduring, persistent learning artifacts**—The flexible audience-viewing formats allow teacher presentations to become enduring resources for learners when they are published on the web or exported as movies, graphics, or document formats such as PDF and shared with students.

Because representation software can support instruction in any content area, the literature reflects many examples of effective uses. For large classes and other groups, presentation or slide decks typically are used in conjunction with computer projection systems, which can include large, high-definition monitor panels, digital projectors and wall-mounted screens, and systems that operate as stand-alone devices. All of these devices enlarge the image produced by the software by projecting onto a wall screen. However, some integration strategies call for representations to be used by individuals working on their own devices.

Technology Integration

Example 4.3

TITLE: Cave Drawings

CONTENT AREA/TOPIC: Social studies (history), art

GRADE LEVEL: 6–8

ISTE STANDARDS•S: Standard 6—Creative Communicator

CCSS: CCSS.ELA-LITERACY.RH.6-8.3, CCSS.ELA-LITERACY.RH.6-8.7

NCSS THEMES: Thematic Standards: 1—Culture and Diversity; 2—Time, Continuity, and Change; 3—People, Places, and Environments; Disciplinary Standards: 1—History

DESCRIPTION: Students learn about prehistoric humans and the messages they left in caves. The teacher makes a presentation and displays example cave drawings. Students discuss the messages being communicated in pictures. Then, they try their hand at “drawing messages.” The lesson wraps up with a discussion on similarities between cave drawings and television, magazines, and newspapers. Students can also create a newspaper advertisement using only pictures and/or symbols and then see whether others can guess the topic of the advertisement.

SOURCE: Based on a concept in cave drawing lesson plan at Teachology website. <http://www.teach-nology.com/>

Current integration strategies for representation software include the following:

- **Demonstrations of content concepts**—The teacher displays a complex concept such as an electrical circuit or light spectrum or a series of examples such as works of art, types of animals, or instruments in an orchestra. This is an ideal way to focus student attention while explaining and visually demonstrating important concepts or pointing out essential features. Technology Integration Example 4.3 illustrates how a teacher amasses visual examples of cave drawings to illustrate a historical artifact.
- **Illustration of problems and solutions**—This is useful when the whole class or individual students need to see example problems or challenges and how to solve them. This representation can be used before students work on their own problems or as a just-in-time resource.
- **Presentation of information summaries**—Teachers use presentations to strengthen whole-class lectures and focus student attention and guide note taking.
- **Automatically repeating presentations**—Many teachers set up automatic presentations of spelling or vocabulary words, objects to identify (e.g., lab equipment, famous names or places), and simulated processes (e.g., butterfly metamorphosis) to display in the classroom to draw students’ eyes to the moving slides.
- **Assessment**—Teachers create representations using pictures, text, or sounds of items (e.g., leaves, bird calls, artwork) for students to identify.
- **Brief or full tutorials**—Teachers can create brief tutorials with presentation software. These can be used for reviews of concepts (e.g., grammar rules) and “how-to” procedures (e.g., steps in a lab procedure, making computer software demonstrations) that allow students to work independently for either in-class work or make up work. Tutorials can also be used to prepare students for taking tests. See a screen from a tutorial example in Figure 4.4. Full tutorials

Figure 4.4 Biology Tutorial Created with Presentation Software

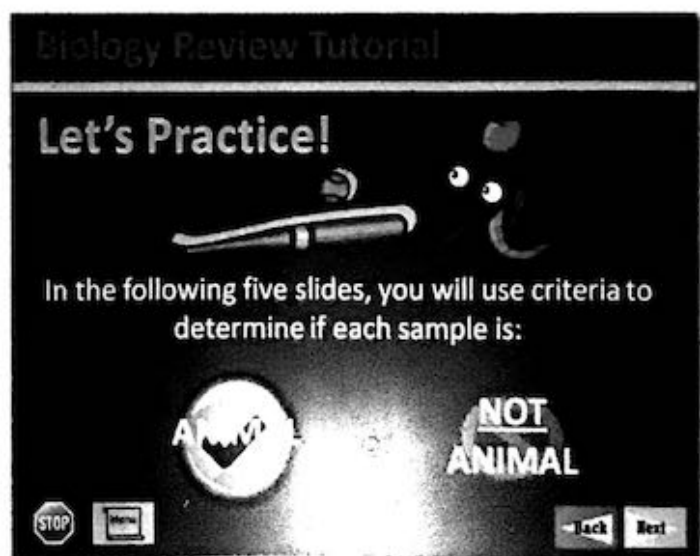


Figure 4.5 *Jeopardy!* Review Game Created with Presentation Software

Solar System Review				
Planets	Moons	Constellations	Sun Words	Night Sky
\$100	\$100	\$100	\$100	\$100
\$200	\$200	\$200	\$200	\$200
\$300	\$300	\$300	\$300	\$300
\$400	\$400	\$400	\$400	\$400
\$500	\$500	\$500	\$500	\$500

are complete instructional sequences that usually have an explanation followed by practice items for which interactive buttons are especially useful. The program can then branch to provide different feedback depending on the answer the user selects.

- **Game-based reviews**—Interactive representations based on popular games such as *Jeopardy!* have become increasingly popular ways to review skills or content. See Figure 4.5 for an example review game. Selecting buttons inserted on the screens send users to various items and to slides with answers and feedback. The Super Teacher Tools site has a large and useful collection of games in a *Jeopardy!* format that reviews content for a variety of content topics ranging from mathematics to history.

STUDENT USE OF REPRESENTATIONS When developing assignments that require students to create representations, teachers should ensure that students focus more on the content learning than on design elements in the representation. Furthermore, teachers should prioritize the use of representation software for multimedia and hypertextual expressions of learning over linear progression of texted bullets. With this in mind, some current representation integration strategies include the following:

- **Collaboration on representations**—Working together on representations of project work or research results gives students important practice in collaborative skills. It also allows students to contribute to the product in a variety of ways rather than just in writing; for example, some students can focus on text message design and some on selecting and creating appropriate graphics. Collaboration can occur face-to-face in classrooms or be facilitated through cloud-based software such as Google Slides and Prezi or the online versions of Microsoft Office and Keynote.
- **Book reports**—Instead of presenting book reports verbally or as written summaries, it is becoming increasingly common for students to report on their reading using presentation slideshows. Teachers often design a standard format or template, and students fill in the required information and add their own graphics.
- **Interactive storybooks**—With this strategy, students build on existing stories or write their own that can be read interactively by others. Those reading these hypermedia stories can click on various places on the screen to hear or view parts of a

Technology Integration

Example 4.4

TITLE: Talking Books Enhance Literacy for Learners with and without Special Needs

CONTENT AREA/TOPIC: Language arts, literacy

GRADE LEVELS: Elementary and middle school students

ISTE STANDARDS•S: Standard 1—Empowered Learner; Standard 4—Innovative Designer; Standard 6—Creative Communicator; Standard 7—Global Collaborator

CCSS: CCSS.ELA-LITERACY.RF.K.1.A, CCSS.ELA-LITERACY.RF.2.3, CCSS.ELA-LITERACY.RF.3.4, CCSS.ELA-LITERACY.RL.3.1, CCSS.ELA-LITERACY.SL.4.2, CCSS.ELA-LITERACY.SL.5.5

DESCRIPTION: When students cannot read independently because of their physical or cognitive difficulties, their reading development is often delayed. The students may not be able to turn pages of a book or turn back to reread a page that they enjoy, so they have to ask someone else to do this for them. Some students might not understand word usage or meanings. This results in less reading and poorer overall literacy. Middle school and elementary school students can team up to re-create popular children's books or write their own books in a digital, hypertextual, multimedia format using presentation software. The resulting books can support students reading through pop-up pictures, animations, and talking text. These students can turn "pages" and click on hyperlinked definitions or further explanations by activating a switch with whatever part of their body has the best voluntary control.

story. This format also lets students go beyond one basic sequence and create their own branches and endings to stories. Candrea (2010) described this strategy as a way to reinforce and enhance children's literacy skills. Thesen and Kira-Soteriou (2011) used Photo Story 3 software for students to create their own digital stories. They, too, felt creating interactive storybooks was a powerful way to enrich all young students' literacy skills. Technology Integration Example 4.4 illustrates the use of these digital storybooks with interactive talking features.

- **Multimedia literacies**—Some teachers feel that students are more motivated to learn content when they can also engage with it through multiple media. Students are able to build or manipulate content representations using text, drawing, graphics, sound effects, and video clips. Technology Integration Example 4.5 uses drawing features and high-quality images to determine scientific knowledge such as size of planetary objects.
- **Representations of research**—Another strategy for integrating representation software is for students to create individual or small-group presentations, such as those with infographics, to document and display results of research they have done and/or to practice making persuasive infographic representations. Having learners become the designers and experts of content and present their work to the class can serve as a powerful technology integration lesson for any domain of learning. Students have created representations of a chemical element (Franklin, 2008), animal behavior (Henson, 2008), interpretation of poems (McVee, Bailey, & Shanahan, 2008), capstone research (Schwebach, 2008), and new vocabulary words (O'Hara & Pritchard, 2008). The commonality among these examples is the focus on having students represent new information they have researched that could be unknown to the teacher or other students as opposed to summarizing textbook information. Digital representations have become so popular for classroom projects that many assessment rubrics for them are now available online (see especially Kathy Schrock's (n.d.) list of presentation rubrics for different grade levels.) Figure 4.6 shows students and their presentation based on original, research-based information that students presented to their class. Technology Integration Example 4.6 describes a lesson in which students research and build knowledge about a historical hero.

Technology Integration

Example 4.5

TITLE: Bringing the Planets Closer to Home

CONTENT AREA/TOPIC: Mathematics (measurement), astronomy

GRADE LEVEL: 8–12

ISTE STANDARDS•S: Standard 1—Empowered Learner; Standard 3—Knowledge Constructor; Standard 5—Computational Thinker

CCSS: CCSS.MATH.CONTENT.7.RP.A.2, CCSS.MATH.CONTENT.HSA.CED.A.1, CCSS.MATH.CONTENT.HSA.REI.B.3, CCSS.MATH.CONTENT.HSG.SRT.A.2, CCSS.MATH.CONTENT.HSG.SRT.B.5, CCSS.MATH.CONTENT.HSG.C.A.1

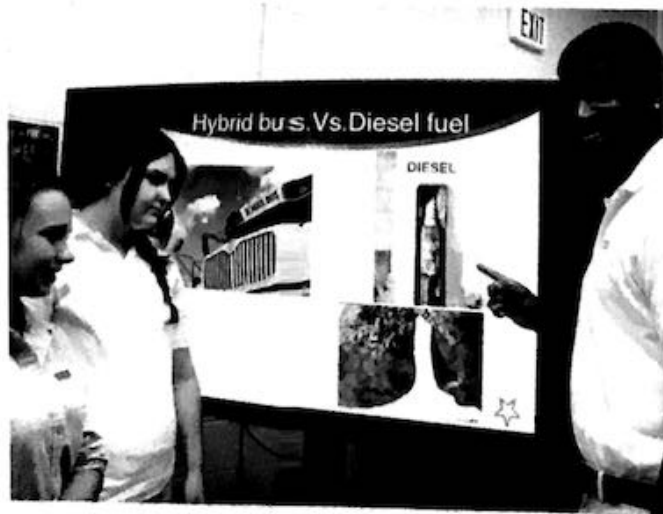
DESCRIPTION: Students begin this project by downloading NASA photos from the Internet (e.g., look for images at the Solarviews website or the Solarsystem portion of the NASA website). Then the students convert the photos to an uncompressed TIF format using an image-editing program such as Adobe Photoshop. The students' task is to learn how to measure the images. First, they use the software to calibrate the images (determine the scale) by comparing the size of each image to a known measurement, such as the diameter of Mars. Then, they multiply the measured distance by the scale to determine the size of other features they have downloaded. In this way, the students can measure and compare features that change, such as the polar ice caps on Mars and Earth. These measurements can be the basis of many projects to study space phenomena.

SOURCE: Based on a concept from Slater, T., & Beaudrie, B. (2000). Far out measurements: Bringing the planets closer to home using image-processing techniques. *Learning and Leading with Technology*, 27(5), 36–41.

INSTRUCTIONAL STRATEGIES FOR REPRESENTATION SOFTWARE Students new to representation software must have adequate time to develop skills in using it before creating products. Some schools have technology or business teachers who teach students these skills and with whom classroom teachers can collaborate. Classroom teachers should coordinate with these teachers to ensure that students have the needed skills prior to a lesson involving them. Online tutorials are available for teaching various software packages; some teachers create their own video tutorials, but these serve best as supplementary learning sources because not all learners have the ability to learn using self-instructional methods. Teachers can combine direct instruction, software

Figure 4.6 Students' Presentation Based on Original Research

(Photo by W. Wiencke)



Technology Integration

Example 4.6

TITLE: Here's My Hero

CONTENT AREA/TOPIC: Language arts, social studies

GRADE LEVELS: 4–5

ISTE STANDARDS•S: Standard 1—Empowered Learner; Standard 3—Knowledge Constructor; Standard 6—Creative Communicator

CCSS: CCSS.ELA-LITERACY.RI.4.3, CCSS.ELA-LITERACY.RI.4.9, CCSS.ELA-LITERACY.RI.5.7, CCSS.ELA-LITERACY.W.4.2.B, CCSS.ELA-LITERACY.W.4.4, CCSS.ELA-LITERACY.W.5.7

DESCRIPTION: Students identify an historical figure they regard as a hero and make a slide presentation about her or him to share with the class. They gather copyright-free (in the public domain) or Creative Commons–attributed images and data from the Internet to add to their slides. The students use digital presentation features to format their slides, create a timeline (organizational chart) of significant events in their hero's life, and insert a table comparing themselves with their hero. Before making their presentations, students learn how to organize oral information for their slides and rearrange slide content for maximum impact.

SOURCE: Based on a concept in a lesson plan at the TechnoKids website: <http://www.technokids.com/computer-curriculum/junior/powerpoint-lesson-plans-technohero.aspx>

exploration, and student sharing of their knowledge of representation features. Teachers who would like to use representation software in classroom lessons should review the features summarized in Table 4.7 and follow the general sequence for introducing software features to students in their classrooms as shown in Table 4.5. Teachers could decide to teach other features of representation software gradually over time, depending on the needs of the specific lessons.

The effectiveness of representations depends largely on the design elements that teachers or students incorporate. Teachers and students should design digital representations with the following key guidelines in mind:

1. **Use large type in projected representations**—Use at least a 32-point font; however, if the audience is large and far away from the presenter, larger type size could be needed. Small type (no less than a 20-point font) can be used to provide citations, references, and sources, which are typically positioned in the lower-left or -right corner of the appropriate slide.
2. **Use colors to show contrast between the text and background**—The audience cannot see text that is too similar in hue to the background on which it appears. Use text with high contrast to the background (e.g., dark text on light-colored backgrounds, white text on dark-colored backgrounds).
3. **Minimize the amount of text**—Use text to focus attention on main points, not to present large amounts of information. Use the representation to enhance, strengthen, and expand on conceptual points.
4. **Keep representations simple**—Designs should be simple, clear, and free of distractions. Too many items can interfere with reading, especially if some items are in motion. In addition, try to employ photographs and images in place of lengthy text when describing context or an event. Finally, try to minimize the number of bullet points (not to exceed three to five) on each individual slide in presentations.
5. **Avoid using too many “fancy” fonts**—Many fonts are unreadable when projected on a screen. Use a plain sans serif (straight lines with no “hands” and “feet”) font for titles and a plain serif font for other text. Avoid using more than three different

fonts throughout the representation to maintain consistency of headings, body text, and pull-out text.

6. **Avoid using gratuitous graphics and clip art**—Graphics interfere with communication when used solely for decoration. Use them only to help communicate and expand on the content, not for the sake of using graphics alone.
7. **Avoid using gratuitous sounds**—Sounds interfere with communication when used solely for effect. They should always help communicate the content, not be used as a transition effect.
8. **Use graphics, not just text**—Well-chosen graphics can help communicate messages. Text alone does not make the best use of the capabilities of representation software. However, with the ever-increasing ease of finding and downloading images and media from online sources, it is important for teachers to introduce concepts of copyright, attribution, and fair use. Require students to document where materials come from and teach them how to cite the sources in their representations properly.
9. **Design for a light room**—Visuals can fade away if the room is too bright, but sometimes it is not possible to present in a dark room. Test representations that will be projected to ensure that all elements are visible in such cases.
10. **Avoid reading text aloud in oral presentations**—Do not read what the audience can read for themselves. Use text to guide the main points of discussion. This will help focus on presenting to the audience as opposed to speaking at the screen. Remember that the presenter—not the presentation—is delivering the information.

Benefits of Using Representation Software

Teachers have identified instructional and assessment benefits of representation software. For example, Roscoe, Derksen, and Curtis (2013) described a process of using **backward design** that first identifies expected student learning outcomes in science and then builds interactive formative assessments and instructional content in presentations on interactive whiteboards. Teachers found that integrating interactive assessment with content representations (e.g., content-related diagrams, pictures) effectively shared content information, engaged and focused students, and allowed informed and immediate adjustments to instruction. Another study found significantly better learner achievement and learner satisfaction among fifth grade students who learned English as a second language with multimodal, interactive representations (e.g., interactive language materials) (Kuo, Yu, & Wei-Hung, 2013).

Researchers also have studied the impact of creating content representations on students. Cause and Chen (2010) claim that for young children, drawing is a representational form of communication that is a precursor to writing and recommend using drawing software on a tablet computer for drawing software's versatility. Walker-Dalhousie and Risko (2008) agree that children's digital drawings exemplify their understandings of textual content and represent learned concepts. O'Hara and Pritchard (2008) found that students who created interactive representation products to illustrate their learning were more active and engaged than students who did not and demonstrated increased understanding of the words and concepts that they studied. Elliott and Gordon (2006) believe that presentation software can support constructivist activities, promote higher level thinking, and engender content-rich understandings. Schul (2010) exemplifies this tenet when describing a teacher who integrated desktop documentary making in which high school students created a brief museum exhibit to interpret historical artifacts, which supported the teacher's constructivist, inquiry-based pedagogy for teaching history.

Challenges of Using Representation Software

- Challenges with using representation software effectively require teachers to understand communication and visual design principles. Ultimate goals of creating effective representations related to message content include the following:
- **Lack of focus on message content**—Tuft (2003) is a leading expert on visualization. He notes that presentation software makes people focus on slides rather than on the message. He argues that presentations (specifically those created with presentation software) should be a supplement to information rather than a substitute for it. Jordan and Papp (2013) also noted that sometimes students use presentation software to substitute for rather than a supplement to information. Jordan and Papp noted the potential for a loss of "connection" between the slides and the listeners when the focus is on reading the slides rather than building on the concepts behind it.
 - **Lack of coherent visual design**—Jordan and Papp (2013) note that teachers who create slideshows do not have a good grasp of visual design. They argue that good design would help them achieve their desired results. For example, they note that the overuse or improper use of bullets and lists that can distract as they process the information they are hearing.
 - **Tendency toward a singular presentation format**—The impact of slide-based software has on teaching. Academic presentations makes educators reshape what they teach. This is inconsistent with developing higher level thinking. Jordan and Papp saw slideshows being used the same way across all disciplines, a teaching style that might not be appropriate for every subject.

Challenges with using representation software effectively require teachers and students becoming more aware of the most effective design principles, as summarized earlier in the design guidelines.

Video Example 4.5 Using Media in Presentations

In this video, a principal talks about the expectation of creating a supportive environment to speak and present using data to communicate their project work.



Challenges of Using Representation Software

Creating and using representation software effectively requires substantial background in communication and visual design principles. Ultimately, the biggest challenges in building effective representations related to message content, visual design, and teaching format include the following:

- **Lack of focus on message content**—Tuft (2003) is among those who feel that presentation software makes people focus on slides rather than the message, concluding that presentations (specifically those created with PowerPoint) become a substitute for rather than a supplement to informational representations. Jordan and Papp (2013) also noted that sometimes students focused so much on the slide features that they neglected important information or sources. Furthermore, Jordan and Papp noted the potential for a loss of “connection” between the person presenting the slides and the listeners when the focus is on reading the slide content rather than building on the concepts behind it.
- **Lack of coherent visual design**—Jordan and Papp (2013) found that many people who create slideshows do not have a good grasp of visual design principles that would help them achieve their desired results. For example, these researchers identified overuse or improper use of bullets and lists that cause problems for learners as they process the information they are hearing.
- **Tendency toward a singular presentation format**—There are also complaints about the impact slide-based software has on teaching. Adams (2006) reported that using slide presentations makes educators reshape what they present in a linear way that is inconsistent with developing higher level skills. Jordan and Papp (2013) saw slideshows being used the same way across all audiences, leading to a single teaching style that might not be appropriate for everyone.

Challenges with using representation software seem best addressed by teachers and students becoming more aware of the most effective design for representation software as summarized earlier in the design guidelines. In brief, these design guidelines

Video Example 4.5 Using Media to Enhance Presentations

In this video, a principal talks about the expectation for students in a one-to-one computing environment to speak and present using data, pictures, video, and other media to communicate their project work.



include showing only a few concepts at a time before having learners apply the information, using less text and more images or diagrams, having eye contact with the audience, and not giving out hard copies of the information.



Check Your Understanding 4.3

Data and Analysis Software for Teaching and Learning

Teachers and students are now collecting and analyzing data often in schools. In some cases, teachers and students are provided analyzed data from which to work and learn. In other cases, teachers and students engage in their own data-generating activities. In these latter cases, various tools assist in collecting data and making sense of them, including online surveys; spreadsheet, statistical, and database software; and charting, graphing, and visualization. Table 4.8 summarizes commonly used software and their functions for teachers and students.

A number of **online survey** tools, such as Google Forms and Qualtrics, enable teachers and students to design and implement their own surveys and questionnaires. Collecting data online has become increasingly popular because it eliminates the need for postal mailings and for respondents to be in any particular location to complete the survey.

Table 4.8 Data and Analysis Software Tools, Functions, and Products

Software Tool	Software Example	Software Function	Sample Product
Online surveys	<ul style="list-style-type: none"> • Qualtrics • Google Forms • SurveyMonkey • SurveyGizmo • Zoomerang • LimeSurvey 	Design multiple types of questions, deploy online for anonymous or identifiable responses, collect range of informational data	<p>Teacher: Formative and summative assessment surveys, tests, parent and student surveys</p> <p>Student: Social science research surveys</p>
Spreadsheet	<ul style="list-style-type: none"> • Microsoft Excel • Google Sheets • Numbers (Apple) • OpenOffice Calc 	Put numerical, textual, graphical information in row-column format; allow numerical and statistical calculations/analysis; support charts and graphs	<p>Teacher: Gradebook, mathematic representations, data analysis, chart creation</p> <p>Student: Data exploration or analysis, budgets, mathematical computation</p>
Statistical	<ul style="list-style-type: none"> • SPSS • SAS • Stata • R • Analyse-it • XLStat • NCSS • Mathematica 	Perform specialized statistical analysis of data; create charts, plots, graphs of data	<p>Teacher: Statistical analysis of experiments and action research studies, statistics instruction</p> <p>Student: Statistical analysis</p>
Database	<ul style="list-style-type: none"> • FileMaker • Microsoft Access • MySQL • Quickbase 	Collect, organize, manage, query, report on data to facilitate data drive decision making	<p>Teacher: Content topic for business and technology classes, backend for website development</p> <p>Student: Use of databases such as ProQuest; creation of searchable database of oral history collection (e.g., interviews and photos) completed in school</p>
Charting, graphing, and visualization	<ul style="list-style-type: none"> • Spreadsheets • Graphing Calculator • Plotly • SmartDraw • The Graph Club 2.0 • Tableau Desktop 	Create images, charts, graphs, diagrams to communicate a meaning or message, especially from a corpus of data or information	<p>Teacher: Conceptual content ideas (migration, population change, boiling point, motion and speed, word usage)</p> <p>Student: Charts and graphs to illustrate data (census, sports, health, steps walked)</p>

Spreadsheets are programs designed to organize and manipulate primarily numerical data. A spreadsheet helps users manage and analyze information, which can be in numerical, text, and graphic forms. Spreadsheet software was the earliest application software available for microcomputers. The term *spreadsheet* can refer either to the program itself or to the product it produces. Spreadsheet products are sometimes also called **worksheets**. The information in a spreadsheet is stored in rows and columns. Each row-column position is called a **cell** and can contain numerical values, words or character data, and **formulas** or calculation commands. One spreadsheet file can contain a number of **sheets** of data, each of which is represented by a tabbed file along the bottom of the file. Spreadsheets also have built-in formatting processes for preparing visual representations of data in charts and graphs. Google Forms, an online survey tool, dynamically and immediately transfers inputted survey data into a linked Google Sheet.

Statistical software packages allow users to enter data and perform calculations needed to accomplish specialized analysis, such as descriptive statistics (e.g., means and standard deviations) and inferential statistics (e.g., *t*-tests and analyses of variance). Although spreadsheets also can perform many of the same calculations, statistical software includes preprogrammed analysis tools to perform calculations with just a few clicks. Teachers can use such software when teaching statistical procedures in a business education course or statistics courses. Although teachers must have considerable knowledge of the proper applications of various statistical procedures, the software can save considerable time in making calculations.

Databases allow users to store, organize, and manipulate information, including both text and numerical data, in a way that makes it easy to locate later. This capability has become increasingly important as society's store of essential information increases in volume and complexity. Database software can perform some calculations, but its real power lies in allowing people to locate information through keyword searches. Most often compared to a file cabinet, a database program stores one item of data in a location usually called a **field** (such as a name, address, or age). Although each field represents one item of information, perhaps a more important unit of information is a **record** (such as that of a student), which stores all items of information related to a particular entry. Although database construction is still taught in some classes (e.g., business and technology), users more often access existing databases, such as library databases, than create databases.

Charting, graphing, and visualization tools automate visual data analysis. The skills involved in reading, interpreting, and producing graphs and charts are useful both to students in school and adults in the workplace. Because people with limited artistic ability usually find drawing charts and graphics freehand to be difficult, visualization software makes producing these useful "data pictures" more efficient and elegant. Teachers and students use visualizations to understand the meaning of the data. Ruthven, Deaney, and Hennessy (2009) are among those who view graphing as an essential tool to enhance algebra and other mathematics instruction and who believe that visualization activities in all subject areas benefit from applications of such software tools.

Integration Strategies for Data and Analysis Software

With ample data and analysis tools available (see Table 4.9), teachers and students have a wide latitude regarding which tools to adopt. The following section describes how teachers and students are using these tools to support their productivity and learning.

TEACHER USE OF DATA AND ANALYSIS SOFTWARE Teachers engage in data collection and/or analysis to help them prepare classroom materials, organize information, and complete calculations that they would otherwise have to do by hand or with a calculator. Common uses of data and analysis software tools include keeping

Table 4.9 Data and Analysis Software Benefits and Features

Software/General Benefits	Description of Common Features
<p>Online surveys—Assists in collecting data</p>	<p>Question formats—Choose multiple choice, true/false, textbox, ranking, rating/Likert, matrix, scales</p> <p>Dynamic and interactive programming—Add branching, piping of responses, video, audio, and image elements</p> <p>Instant tracking—Use email invitations, reminders; track responses</p> <p>Multilingual support—Translate surveys into other languages</p> <p>Data analysis and reporting—Use built-in software tools to generate, share, export reports and graphs of data</p> <p>Data download—Download survey data in spreadsheet-ready formats</p> <p>Educational discounts—Allows free access (with fewer features) or educational versions at a low cost</p>
<p>Spreadsheets—Facilitates data analysis, graphing, and visualizing numerical concepts</p>	<p>Organization of information—Format row-column information for easy reading, digesting</p> <p>Calculations—Use formulas for arithmetic; mathematical, statistical, trigonometric, logical, and financial functions; automatic recalculations when information is changed</p> <p>Data format—Define alignment, color, style, fill</p> <p>Templates—Adapt preformatted models of worksheets (e.g., budgets, checkbooks, gradebooks)</p> <p>Graphics and interactivity—Insert graphics, movies, shapes, call-outs, live URLs</p> <p>Collaboration—Enables multiple users to work concurrently on spreadsheet</p> <p>Charts and graphs—Created automatically from data</p> <p>Interoperability—Read, use other data files such as those produced by statistical software; add data collected in a Google Form immediately to a linked Google Sheet</p> <p>Exportability—Publish to web or export as PDF, data files</p>
<p>Statistical Analysis Software—Performs complex mathematical and statistical calculations</p>	<p>Graphical user interface—Use menus, dialog to analyze data</p> <p>Extensive statistical tool—Run standard to advanced analyses such as tabulations, ANOVA, linear regression, power analysis, multilevel models</p> <p>Analysis—Use embedded analysis syntax to perform calculations</p> <p>Graphic creation—Use graph editor to create a range of graphic charts, plots, graphs from data</p>
<p>Databases—Organizes information for easy retrieval</p>	<p>Desktop database—Enter data to build relational database of information</p> <p>Autocomplete data—Reduce errors by using drop-downs, recommendations based on typing, macros</p> <p>Template—Use professionally designed document for databases, apps</p> <p>Integration—Import data from student information systems (SIS) for customized reports</p> <p>Custom app development—Create browser-based applications allowing queries and reports for end users with existing database</p>
<p>Charts, graphs, visualizations—Creates graphical representations of data to visualize mathematical concepts or engage in inquiry tasks</p>	<p>Graphic creation—Use tools to build a range of graphic charts, plots, graphs, visualizations from data</p> <p>Collaboration—Access tools simultaneously with multiple users (only in some cloud-based apps)</p> <p>Data analysis—Link, import, manually enter data</p> <p>Templates—Use professionally designed preformatted document to guide development of visualizations</p> <p>Sharing—Export graphics in multiple formats such as PDF or image files, embed graphics on web pages, build presentations or dashboards</p>

budgets for classrooms, school clubs, and field trips; preparing performance checklists for assessment purposes; grading objective tests automatically; and teaching mathematical or analytical topics. Teachers seek data and analysis tools for the following:

- **Polling students**—Looney (2008) identifies online surveys as an ideal way to obtain students' feedback on any given topic, such as how they liked a classroom activity or their reactions to a poem.
- **Saving time**—Users save valuable time by completing essential data collection or calculations quickly and accurately. Data entries, calculations, and visualizations also can be changed, added, or deleted easily with formulas or preset syntax that automatically reconfigures output with new information.
- **Organizing displays of information**—Spreadsheets, databases, and some charts can store information in columns and rows, making them ideal tools for designing textual information such as schedules and attendance lists that can contain few numbers and no calculations at all.
- **Examining student achievement data**—With adequate analysis skills, teachers who have timely access to student achievement data can analyze it to determine learning gaps and proficiencies among students. For example, a teacher could analyze the results of practice or interim tests to help target subsequent instruction on high-need areas. If teachers engage in **action research**, they often collect and analyze data on student learning. These activities can be accomplished by using spreadsheets, statistical software, and analysis and visualization tools built in to student information software (SIS).

Technology Integration

Example 4.7

TITLE: How the Electoral College Works—A Visual Demonstration

CONTENT AREA/TOPIC: Civics, elections

GRADE LEVEL: 9

ISTE STANDARDS•S: Standard 1—Empowered Learner; Standard 3—Knowledge Constructor; Standard 5—Computational Thinker; Standard 7—Global Collaborator

CCSS: MATH.CONTENT.HSS.ID.A.2, CCSS.MATH.CONTENT.HSS.ID.A.3

NCSS THEMES: Thematic Standards: 6—Power, Authority, and Governance; Disciplinary Standards: Civics and Government

DESCRIPTION: After each class holds a mock election and the electoral votes of each class in the school based on enrollment numbers are recorded, the teacher creates a spreadsheet to match the list of classes and their popular and electoral votes. Students enter the election results data on the spreadsheet or have it populated with Google Forms. The teacher displays the spreadsheet on a large monitor so the whole class can see the results as they are entered. Through this activity, students can see that if a very few of the popular votes in key areas are changed, the results of the election could be reversed. The class discusses these results as well as the possibility that a candidate could win the popular vote and lose the electoral vote.

SOURCE: Based on a concept from the Getting into the Electoral College lesson at the NCTM Illuminations site. <http://illuminations.nctm.org>

- **Building visual teaching demonstrations**—When concepts can be clarified by concrete representation, spreadsheets, charts, graphs, and visualizations contribute to effective teaching demonstrations by illustrating abstract concepts and providing graphic illustrations of what the teacher is trying to communicate. This can offer an efficient way to demonstrate numerical concepts such as multiplication, percentages, and numerical applications. For example, a teacher used a survey tool and spreadsheet to teach about the concept of electoral votes and popular votes as described in Technology Integration Example 4.7.

STUDENT USE OF DATA AND ANALYSIS SOFTWARE Teachers can incorporate data and analysis in many ways to enhance learning effectively in all subject areas. Following are current integration strategies that allow students to use data and analysis software:

- **To collect and analyze data**—When students must track data from classroom experiments or online surveys, spreadsheets or databases help organize these data and allow students to perform required mathematical or descriptive statistical analyses on them. Technology Integration Example 4.8 highlights young students who track and graph data from a school-wide food drive.
- **To support posing and testing hypotheses**—Data and analysis tools make posing what-if questions and testing hypotheses feasible as part of inquiry. They also help students visualize the impact of changes in numbers. Because values and linked charts or graphs can be automatically recalculated or redrawn when changes are made in a worksheet, a user can play with numbers and immediately see results.
- **To identify sources of data**—In addition to collecting original data with online surveys or observational techniques, students need skills in locating and organizing information to answer questions and learn new concepts. Much of the world's information is stored in datasets that are becoming more available to students and other nontechnical people for everyday use. Many database activities are designed to instruct students in these searches and to provide practice in looking for

Technology Integration

Example 4.8

TITLE: Engaging Special Education Students in Math Concepts

CONTENT AREA/TOPIC: Mathematics, special education

GRADE LEVEL: 2

ISTE STANDARDS•S: Standard 1—Empowered Learner; Standard 3—Knowledge Constructor; Standard 4—Innovative Designer; Standard 5—Computational Thinker; Standard 6—Creative Communicator

CCSS: CCSS.MATH.CONTENT.2.MD.D.10, CCSS.MATH.PRACTICE.MP5

DESCRIPTION: In a two-week project that emphasizes authentic problem solving, students collect data about the success of their school's food drive and use software to graph the information. They enter data into a spreadsheet, generate a bar graph, and hang the graph in the room as a focal point of discussion. The activity especially benefits students with challenges such as autism by preventing frustration with graphing by hand and keeping them focused on the concepts that the data illustrate.

SOURCE: Based on a concept from Ward, R. (2006). Engage students with graphing software. *Learning and Leading with Technology*, 34(1), 35.

information in various sources. Students are being called to develop **computational thinking** skills because data analysis and interpretation are becoming prominent in the global world (Southworth, Mokros, Dorsey, & Smith, 2010). Many organizations provide free access to data, including bird sightings (Cornell University), U.S. census reports, teens' use of technology (Pew Organization), health and disease (Centers for Disease Control and Prevention), and sports (baseball databank). Technology Integration Example 4.9 shows how students can obtain and analyze data from two cities to build data-based reasoning for differences in climate.

- **To support visualization**—Students can use data and analysis tools to create graphical representations of data, such as timelines, charts, and graphs to visualize mathematical concepts or engage in inquiry tasks. Students can build an understanding of the persuasive power of information and pattern discovery with data.

Technology Integration

Example 4.9

TITLE: Comparing the Weather in Two Locations

CONTENT AREA/TOPIC: Science, weather

GRADE LEVEL: 8

ISTE STANDARDS•S: Standard 1—Empowered Learner; Standard 3—Knowledge Constructor; Standard 4—Innovative Designer; Standard 5—Computational Thinker; Standard 6—Creative Communicator; Standard 7—Global Collaborator

CCSS: CCSS.MATH.CONTENT.8.SP.A.1, CCSS.MATH.CONTENT.8.F.B.5, CCSS.MATH.PRACTICE.MP5

NSTA: MS-ESS2-1, MS-ESS2-5, MS-ESS3-5

DESCRIPTION: Students work in small groups to gather weather data from NOAA's National Weather Service website on two cities that the teacher assigns them or the students choose. They enter the data on a spreadsheet and do calculations to determine temperature and rainfall averages for given periods of time. They compare the two cities' weather patterns and analyze them to determine the reasons for the differences they found. Finally, they report on their findings to the class.

SOURCE: Based on a concept in a lesson plan at the Hotchalk website. <http://www.lessonplanspage.com>

Table 4.5. Teachers could decide to teach other features of data and analysis gradually over time, depending on the specific needs of lessons.

Benefits of Using Data and Analysis Software

Spreadsheets help students visualize numerical concepts better than other less dynamic tools. Ray (2013) used pre- and post-achievement data to indicate the impact of “spreadsheet simulations,” or exercises that ask students to collect data in two or more different ways, insert the sets of data in a spreadsheet, and compare the results of the data collection strategies. He found that these exercises improved the comprehension of highly abstract concepts in biology. There is also considerable evidence that spreadsheets have proven useful for teaching concepts in many areas, including calculus (Benacka, 2016a), modeling and probability (Beigie, 2010; Benacka, 2016b), climate change (Krall, 2010), ocean acidification (Perera & Bopegedera, 2014), physics (Benacka, 2010), and sports (Bennett, O’Shaughnessy, & Bedford, 2011). The literature contains numerous testimonials by teachers who have used spreadsheets and databases successfully to teach topics ranging from mathematics to social studies.

Bargagliotti (2014) argues that both teachers and students need data literacy skills, specifically the ability to view charts and graphs presented by news media, extract information, and build understanding. In a study of teachers’ data literacy skills, Means, Chen, DeBarger, and Padilla (2011) found that teachers working in small groups expressed more accurate responses to data scenarios than did individual teachers. Thus, collaborative work with data might lead to increased interest and accuracy among teachers.

Increased emphasis is being placed on developing students’ information and data literacy, especially to develop students as citizens in a democratic society. Philip, Olivares-Pasillas, and Rocha (2016) argue for expanded opportunities for students to interpret and create data visualizations. From their research that examined high school classroom discussions and interactions, Philip et al. argue that visualizations from public media sources should be used in science, technology, engineering, and mathematics (STEM) learning to inquire into data regarding racial literacy and race and power. All real world, data-based visualizations are bound by social, economic, political, and racial contexts.

Challenges of Using Data and Analysis Software

Although data and analysis tools have a reputation in education for utility and versatility in teaching, challenges that teachers and students face when using them include the following:

- **Limited teacher confidence and proficiency**—Teacher preparation does not always enable new teachers to know how and where to find data, how to understand and interpret it, and how to use it for posing questions and decision making (Bargagliotti, 2014; Means et al., 2011), yet teachers are often expected to analyze and use student data to make instructional decisions. Furthermore, textbooks tend to obscure scientific graphs as data when graphs are presented with missing scales and/or a lack of textual interpretation of the data (Egger & Carpi, 2013).
- **Establishment of optimal learning conditions**—Best practices for teaching data literacy include hands-on, project-based learning using real-world data and problems that are interesting and significant to the learners (Ridsdale et al., n.d.). It can be difficult for teachers to identify content-specific challenges with available data about which students can inquire (Egger & Carpi, 2013). If teachers choose to pursue an original student research project involving data collection, projects may require longer time to complete and might not correspond with fast-paced content coverage common to current emphasis on standardized testing preparation.
- **Misconceptions that students are technologically or data knowledgeable**—Societal messages promote the idea that younger generations are “digital natives,”

yet research indicates a lack of breadth in technological capabilities (Hughes, technological skills students commonly perceive as interpretable, which textbooks (Egger & C



Check Your Understanding

Shared Writing 4.1 D

Planning and Organizing for Teaching

Planning and organizing instruction, calendar, and time management. A summary of these

Lesson Planning

Tools that help teachers create lesson plans or lesson maps, apps and provide on-screen templates, standards, materials, and resources. Collaborative planning with other teachers.

Table 4.10 Planning and Organizing

Software Tool Category/Example

Lesson planners—Helps teachers create and document lesson plans

Scheduling, calendar, and time management—Helps teachers organize their time

Outlining and concept mapping—Helps teachers and students organize their ideas into a concept map form

yet research indicates that K–12 students and recently certified teachers have a lack of breadth in technological abilities, which tend to focus only on social media capabilities (Hughes, 2013; Thompson, 2013). Thus, both teachers' and students' technological skills should not be overstated or assumed. In addition, students commonly perceive data-based graphics as pictures rather than as data that are interpretable, which is reinforced by the graphics and photographs dominating textbooks (Egger & Carpi, 2013).



Check Your Understanding 4.4

Shared Writing 4.1 Data Literacy for K-12 Students and Teachers

Planning and Organizing Software for Teaching

Planning and organizing tools for teachers include lesson planning software; scheduling, calendar, and time management tools; and outlining and concept mapping software. A summary of these with sample software is shown in Table 4.10.

Lesson Planning Software

Tools that help teachers develop and document their lessons are sometimes called lesson makers or lesson planners. Most of these programs are available online or as apps and provide on-screen prompts for specific lesson components, such as objectives, standards, materials, and activity descriptions. Many, like Common Curriculum, have collaborative features facilitating sharing and development with other teachers.

Table 4.10 Planning and Organizing Software

Software Tool Category/Benefit	Example Software
Lesson planners —Helps teachers prepare and document lesson plans	<ul style="list-style-type: none"> • CorePlanner • Planboard • Common Curriculum • Nearpod • MyLessonPlanner • PlanbookEdu • iLessonReady
Scheduling, calendar, and time management —Helps teachers organize their time and plan activities	<ul style="list-style-type: none"> • Google Calendar • EduSyncTeacherCal Pro • Calendly (appointment slots for Google Calendar) • Remind • SignUpGenius • Doodle • Google Classroom • Canvas
Outlining and concept mapping —Helps teachers and students organize their ideas in outline or concept map form	<ul style="list-style-type: none"> • LucidChart • Kidspiration • Inspiration • SmartDraw • Venn Diagram (from ReadWriteThink) • Bubbl.us

Scheduling, Calendar, and Time Management Software

Several kinds of tools help teachers organize their time. Many schools and teachers are using Google Calendar to schedule daily, weekly, and monthly events, appointments, and notes. Teachers can create calendars with different sharing settings including a collaborative calendar that can be shared or embedded on websites. For example, events can be shared with students or parents and then reminders can be sent before the events occur. Use of allocated appointment slots allows other teachers, parents, and students to book appointments. Because Google Calendar is cloud-based, teachers can access it on any Internet-accessible device. Many calendar templates preloaded with significant events are available for printing or digital use. Scholastic and Education World provide such tools.

School communication can be improved among teachers, colleagues, parents, and students using the Remind app, which facilitates multilingual, trackable messaging, reminders, and communication. Educators have used apps such as SignUpGenius to organize classroom and field trip volunteers. Some schools are adopting **learning management software** that has built-in calendars and assignment scheduling to support **blended learning**.

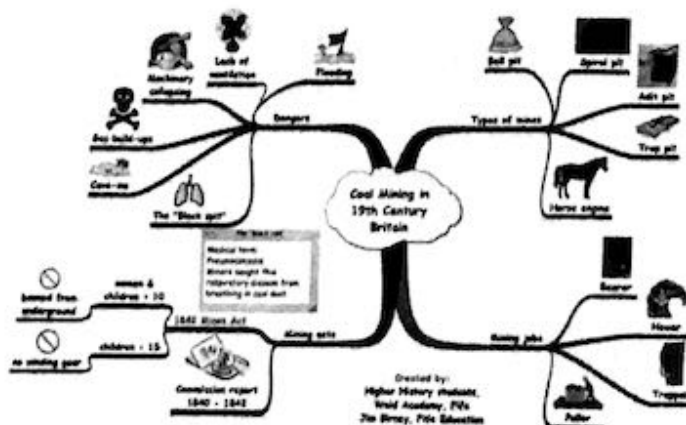
Outlining and Concept Mapping Software

Teachers use outlining tools for complex activities, such as curriculum mapping and development. **Outlining** is built into various word processing software that is designed to prompt users as they develop outlines by automatically indenting and/or supplying the appropriate number or letter for each line in the outline. **Concept mapping software** tools are designed to help people think through and explore ideas or topics by developing outlines and visual concept maps as represented in Figure 4.8. Concept mapping software allows textual and visual representations, is exportable to many formats including interactive websites, and can offer collaboration.

Outlining and concept mapping tools help students learn writing skills, order their thoughts prior to writing, and visualize systems such as those in science or a series of steps in computer programming or the order of historical events. Inspiration is one of the most popular of these tools. Kidspiration is a version of this software designed for younger users. MacArthur (2009) discusses the research conducted on these powerful instructional tools and gives good examples of how to use them to help struggling writers. Dougherty, Custer, and Dixon (2012) recommend guidelines for student use of concept maps in precollege engineering instruction. Technology Integration Example 4.10

Figure 4.8 Sample Concept Map in Inspiration

SOURCE: Mindmap created using Inspiration® by Inspiration Software, Inc.



Technology Integration

Example 4.10

TITLE: Writing Our Own Fairy Tales

CONTENT AREA/TOPIC: Language arts, writing

GRADE LEVELS: Grades 3–4

ISTE STANDARDS•S: Standard 1—Empowered Learner; Standard 3—Knowledge Constructor; Standard 4—Innovative Designer; Standard 6—Creative Communicator; Standard 7—Global Collaborator

CCSS: RL.3.3, RF.3.4(a), W.3.5, RL.4.6, W.4.3(e), SL.4.6, CCSS.ELA-LITERACY.SL.5.5

DESCRIPTION: The teacher first reads two different fairy tales aloud to the class and helps the students brainstorm about what the stories have in common. As they talk about the stories, the teacher uses Inspiration software to illustrate the common aspects and themes that make fairy tales so interesting (e.g., central character/s, colorful setting, conflict or challenge, resolution, moral or lesson). The concept map shows how these aspects appear in both fairy tales. She asks students to tell one of their other favorite fairy tales and fills in the concept map template with the themes and common aspects to their fairy tale. She asks students to work in pairs or threes to create their own fairy tale, first sketching out the elements in an Inspiration template and then writing and illustrating them. Finally, the groups share their fairy tales, showing the concept map that illustrates their “essential elements” for their fairy tale.

SOURCE: Based on a concept from the Fairy Tale Picture Books lesson plan at the ReadWriteThink website: <http://www.readwritethink.org/>

demonstrates a teacher’s use of a concept map to identify essential commonalities in fairy tales after which students prepare a concept map of a new fairy tale before writing and illustrating it.



Check Your Understanding 4.5

Instructional Material Generators

Material generators are software programs or apps that help teachers produce instructional materials for the classroom. There are generators for web design, whiteboard activity, worksheets, puzzles, individualized education programs (IEPs), graphic document makers, and PDF and form makers. A summary of the benefits and sample software is shown in Table 4.11.

Web Design Software

Although educators and others can create web pages and websites using a programming language called **hypertext markup language (HTML)**, it is easier and faster to use web design software. Also known as **web page editors**, these tools allow people to create web pages in the same way they would use word processing to create documents. They insert text, graphics, and hypermedia links to create the pages, and the software automatically creates the HTML code that allows the pages to be linked and available on the web.

The web pages that teachers and students can design with software are for both instructional and productivity applications. Some common uses include:

- **Classroom news, activities, and resources**—Many teachers use web design software to create their own classroom websites. These are multipurpose sites with items ranging from announcements and information about current curriculum to

Table 4.11 Instructional Material Generator Software

Software Tool Category/Benefit	Example Software
Web page and website design software —Teachers design web pages and websites to share information or house often-used links; students design web pages to learn the skill and to display the results of project work or research	<ul style="list-style-type: none"> • Google Sites • Weebly for Education • WordPress • EduBlogs • Wix
Whiteboard activity software —Teachers create lessons for use with interactive whiteboards	<ul style="list-style-type: none"> • SMART Learning Suite <ul style="list-style-type: none"> • <i>Notebook</i> • <i>Amp</i> • <i>Lab</i> • <i>Response 2</i> • Promethean ActivInspire • Promethean ClassFlow • EduCreations • ExplainEverything
Worksheet and puzzle generators —Teachers create puzzles and worksheets to allow skill practice	<ul style="list-style-type: none"> • Crossword Puzzle Maker • Worksheet Works • Quia Web
IEP Generators —Teachers create individual education plans (IEP) for special education students	<ul style="list-style-type: none"> • IEP Online • EasyIEP • PowerIEP • PowerSchool
Graphic document makers —Teachers and students create awards, recognitions, flyers, cards, and other decorated documents	<ul style="list-style-type: none"> • Print Shop Deluxe • SmartDraw Cloud
PDF and forms makers —Teachers and students create documents in Portable Document Format (PDF) and create forms that can be completed online	<ul style="list-style-type: none"> • Adobe Acrobat Pro • PDF Maker Pilot • Cute PDF

locations from which students and/or parents can download handouts or homework. These sites can also have links to websites that teachers know they will be using often to support instruction. For example, if they use certain sites for puzzles and games to provide practice for students, teachers can make part of the website have links to these activities.

- **Web-based lessons**—Teachers can create their own instructional activities that students can do on the web. More details and examples of these lessons will be presented later in this book.
- **Student-produced work**—Teachers can have students create web pages instead of documents to show off their creative work or research results. Students find it very motivating when they realize that their work will be available online and can be seen by others. Teachers must be sure to know their schools' policies regarding sharing student work on publicly accessible online areas.

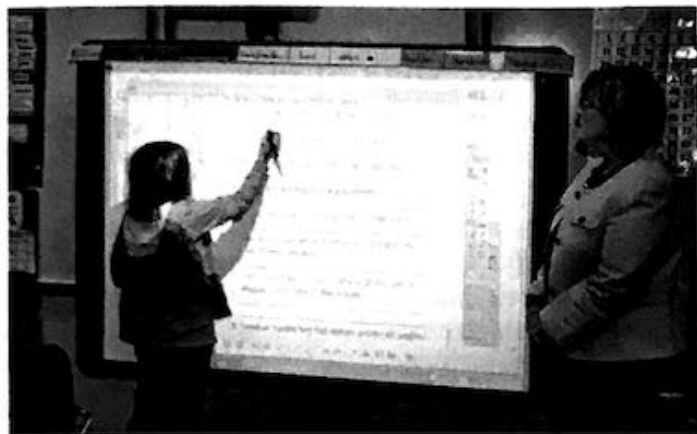
Interactive Whiteboard Activity Software

An **interactive whiteboard (IWB)** is a display screen connected to a computer that allows information that is projected on a screen to be manipulated with special pens, hands, or other mobile devices. IWB systems also allow drawings or notes from a given session to be saved, shared, or reused later. The most popular interactive whiteboards are the Promethean ActivBoard Touch, ActivPanel and ActivTable, and SMART Technology's SMART Board and SMART kapp iQ. Promethean also offers two kinds of student response systems, ActivExpression and ActivVote, for interactive, formative feedback during lessons. See a student who is touching the screen to select or enter answers pertaining to an interactive whiteboard lesson in Figure 4.9.

Each brand of interactive whiteboard comes with its own program, called **interactive whiteboard activity software**, that allows teachers to author and display lessons. For example, SMART offers the SMART Learning Suite, software for creating and recording lesson activities for formative assessment, collaborative workspaces, and

Figure 4.9 Student Using an Interactive Whiteboard

(Photo courtesy of W. Wiencke)



game-based lesson activities. For the Promethean ActivBoard Touch or ActivPanel interactive whiteboard, teachers can use ActivInspire to create lessons and assessments and to export or save lessons. ClassFlow allows searching a marketplace of lessons made by other teachers. The software comes with a resource bank of images, graphics tools, and text tools that teachers can use to author activities in much the same way as they would use PowerPoint's program and resources to create slides. Whiteboard activity software is required to give whiteboard lessons their interactive qualities. For example, teachers can use whiteboard activity software to develop a lesson that allows students to move objects around on the whiteboard or touch the screen to select or enter an answer to a mathematics problem. Technology Integration Example 4.11 highlights a lesson in which students respond to historical moments.

Other software apps, such as Explain Everything, offer collaborative, interactive whiteboard tools for mobile devices. These tools facilitate **screencasting**, a recorded video of content shown on the screen with user audio narration if desired. The app has drawing tools and others that import graphics, video, and files. Teachers use screencasting to prepare content representations for advance viewing before teaching,

Technology Integration

Example 4.11

TITLE: The Road to Revolution

CONTENT AREA/TOPIC: Social studies, history

GRADE LEVELS: 9–12

ISTE STANDARDS•S: Standard 1—Empowered Learner; Standard 3—Knowledge Constructor

CCSS: CCSS.ELA-LITERACY.RH.9-10.2, CSS.ELA-LITERACY.RH.9-10.3, CCSS.ELA-LITERACY.RH.11-12.6

NCSS THEMES: Thematic Standards: 1—Culture and Diversity; 3—People, Places, and Environments; 6—Power, Authority, and Governance; Disciplinary Standards: 1—History

DESCRIPTION: Students listen to scenarios of events leading up to the Revolutionary War as the teacher displays information about the events on the interactive whiteboard. Using clickers, students choose what they would have done in response to each event. Each choice leads them to the next event where they see the results of their choices. In the end, they reach the time when Britain closed Boston Harbor, and students must decide whether they identified most with loyalists, patriots, or neutralists.

SOURCE: Based on a concept from the Smart Exchange lesson "The Road to Revolution." <http://exchange.smarttech.com>

explanation videos to visualize or work with ideas extemporaneously in class, and media-based assessment feedback for student work. Students use these tools primarily to create representations of their knowledge.

Worksheet and Puzzle Generators

Teachers can use software to produce a number of items for student use. **Worksheet generators** help teachers produce exercises for practice by prompting the teacher to enter questions of various kinds, but they usually offer no options for completing exercises on screen or for grading them. In many cases, software generators for tests and worksheets are similar enough to be used interchangeably, and some packages are intended for both purposes. **Puzzle generators** automatically format and create crosswords, word search puzzles, and similar gamelike activities. The teacher enters the content, and the software formats the puzzle. Refer to Table 4.11 for popular worksheet and puzzle generation sites. Common uses of worksheet and puzzle generators include:

- Practice for lower level skills, such as math skills
- Cloze comprehension exercises with certain words removed that students fill in on the blanks
- Exercises to review words and definitions

Individualized Education Program (IEP) Generators

Teachers of students with special needs are required to complete paperwork regarding student progress. Federal legislation, such as the Individuals with Disabilities Education Act (IDEA) and the Americans with Disabilities Act (ADA), requires that schools prepare an **individualized educational program (IEP)** for each student with special needs. These IEPs serve as blueprints for each student's special instructional activities, and teachers must provide documentation that such a plan is on file and that it governs classroom activities. **IEP generator** software assists teachers in preparing the programs (Wilson, Michaels, & Margolis, 2005). Like test and worksheet generators, IEP generators provide on-screen prompts that remind users of the required components in the plan. When a teacher enters all the necessary information, the program prints out the IEP in a standard format. Some IEP generation programs also accept data updates on each student's progress. See also the Adapting for Special Needs feature.

Graphic Document Maker

Graphic document makers are software tools that simplify the activity of making highly graphic materials, such as award certificates and greeting cards. These tools offer sets of clip art and predesigned templates to which teachers and students can add their own content. For example, teachers have found certificates to be a useful kind of recognition for congratulating students for accomplishments; students can take the certificates home and share them with parents and friends. Most certificate makers include more templates for various kinds of achievements than word processing software does. Teachers can select the template that is appropriate for the recognition intended (e.g., completing an activity, being a first-place winner) and enter the personal information for each recipient. Students frequently find it motivating to use these packages to design their own certificates, cards, and flyers. The most popular of these document makers is Print Shop (Broderbund). See Table 4.11 for information about instructional material generator. Although graphic document makers are still being used, word processing and drawing software packages now offer many of the same elements, including a variety of templates for various awards.

Box 4.2

Adapting for Special Needs: Software Tools

As students enter middle school, the demands of changing rooms and teachers each class period challenge the organizational abilities of even the best students. Suddenly, they have to do assignments in many different subjects and keep track of books and folders for each one. Fortunately, most middle schools have a schoolwide system (e.g., assignment notebooks, folders, homework help web pages) to help students get organized and keep track of all that they are supposed to know and do. However, by October each year, some students are "organizationally failing," which makes it difficult for them to do well in their classes.

Staying organized and keeping track of important details is a lifelong challenge for everyone, and difficulty with memory storage and retrieval is a fundamental characteristic of many individuals with learning disabilities. As a result, it is important to help these students find an information management system that is highly effective for them. Many of the following organizational tools have features that offer benefits to these students. However, please note that tools alone will not help students overcome deficits in organization and planning.

Teachers and parents must commit to monitoring the use of the tools and teaching new strategies so that the student can maximize the power of the tool.

- Evernote—Encourages users to make artifacts (a note, image, or URL) of things they have to do, which are then indexed and made searchable
- Remember the Milk—Helps users create a system of reminders of tasks to do
- Things—Lets users create an agenda and daily/weekly/monthly to-do lists
- Toodledo—Helps users organize tasks they have to do into folders and subtasks
- Todoist—An online task manager to help users keep organized
- Vitalist—A personal organization and productivity system
- Voo2Do—An online system that helps users track priority, due dates, and time estimates for a number of different tasks
- PocketMod—Provides a way to create a pocket guide of things to do and remember

—Contributed by Dave Edyburn

PDF and Form Maker

Portable document format (PDF) file software created by Adobe permits viewing and sending documents in a general format that displays all of the formatting and design elements (e.g., margins, graphics) of the original document without requiring access to the software used to create it. Teachers can create a PDF using most software by choosing to save the document in the PDF format. The resulting PDF files can then be shared exactly as formatted and viewed by anyone with the free Adobe Acrobat Reader. PDFs can be used in conjunction with **forms makers** such as PDF Maker Pilot, a software tool that creates documents and web pages with forms that can be filled in on screen. Teachers find forms makers useful because they make it easy to create forms to collect information from students, parents, and faculty and to implement surveys as part of action research projects. However, Google Forms is likely an easy solution for teachers who do not have extensive graphics or layout needs. These software tools structure the process and make the design simple to accomplish. As teachers create these forms, they can store them as templates for later use and perhaps revise them.



Check Your Understanding 4.6

Assessment Software

Teachers use a range of software and hardware tools for formative and summative assessment, including student response systems, rubric and test generators, digital portfolio systems, gradebooks, SIS, and computer-based testing systems. A summary of available software for assessment and their benefits is shown in Table 4.12.

Video Example 4.6 Using Interactive Whiteboards and Clickers for Formative Assessment

In this video, a principal explains how teachers use IWBs and clickers for formative assessment.



Student Response Systems

Used primarily for formative assessment, **student response systems (SRS)** (also called *audience response systems*, *personal response systems*, **clickers**, and *classroom response systems*) are software programs or combinations of handheld hardware and software programs that permit each student in a classroom to answer a question simultaneously (Figure 4.10). SRS also permit the teacher to see and display a summary of results immediately. The software ranges from that sold with a textbook to new technologies with which any digital device can be used to respond to an instructor's questions. Examples of SRS uses range from vocabulary games to comprehension checks during a classroom presentation that offer an easy way to engage all students during whole-group instruction. Successful SRS uses have been reported in science (Binek, Kimla, & Jarosz, 2016; Moss & Crowley, 2011), mathematics (Popelka, 2010), second language communication (Agbatogun, 2014), and English language arts (Moratelli & DeJarnette, 2014).

Studies and use cases of these tools in K–12 classrooms have reported results including improved student engagement, increased active learning, and greater

Figure 4.10 Students Responding by Using a Clicker

(Photo by W. Wiencke)



Table 4.12 Assessment Software

Software Tool Category/Benefit	Software Examples
Student response systems or clickers —Teacher displays a question or problem (sometimes on interactive whiteboard), all students answer it at the same time, and the system summarizes and displays results immediately; teachers use the systems to engage students and check understanding formatively	<ul style="list-style-type: none"> • Turning Point: Polling and Response Options • Kahoot! • Socrative • iRespond • SMART Response 2 • ActiVote, ActiExpression
Rubric and test generators —Teachers create tests and test item banks, administer tests online; teachers create or adopt rubrics for grading complex products or performances	<ul style="list-style-type: none"> • RubiStar • Rubric Maker • iRubric • ClassDojo • Google Forms and Flubaroo • Quizlet • ForAllRubrics • StudyBlue • Exam View Assessment Suite • EasyTestMaker • iSpring Quizmaker or Free Quiz Maker
Computer-based testing systems —Students take tests on the computer or online, and the software grades tests and compiles data for grading and decision making	<ul style="list-style-type: none"> • iReady • SuccessMaker • ALEKS • Sapling Learning • Compass Learning
Portfolio systems —Students can capture and collect evidence of their learning and engage in deeper reflection on their knowledge development by examining their learning products/performances over time. Some portfolios can engage others, such as teachers or parents, in interactive communication	<ul style="list-style-type: none"> • SeeSaw • DIGication • Mahara • Adobe Acrobat Pro • LiveBinder • Google Sites with Google Drive • eduClipper • Prezi
Electronic gradebooks and student information system (SIS) —SISs allow teachers to track attendance and grades. Other functionality facilitates parent and student communication, calendars, report cards, state reporting, and integration with systems such as learning management systems (LMS)	<ul style="list-style-type: none"> • Infinite Campus • PowerSchool • Synergy

achievement (Mccrea, 2014; Moratelli & DeJarnette, 2014; Waight, Chiu, & Whitford, 2014). DeSorbo, Noble, Shaffer, Gerin, and Williams (2012) found that elementary school students grouped according to paper-and-pencil use and SRS use achieved about the same in a health education program but that both students and teachers preferred the clickers over other ways of gauging progress. Moratelli and DeJarnette (2014) found that clicker-based review sessions for fifth grade urban students led to improved test scores for all students, including low achievers. Stowell, Oldham, and Bennett (2010) also found that students were less likely to conform to the group's opinion and felt more comfortable responding with this tool than raising their hands when questions being discussed were controversial.

Rubric and Test Generators

Software tools are available to help teachers produce rubrics and tests (see Table 4.12).

RUBRIC GENERATORS A rubric is an assessment instrument that measures more open-ended assignments such as writing tasks, performances, and presentations. The rubric includes criteria that will be assessed and descriptive levels of quality for each criteria. Rubrics should also be shared with learners because they help guide students' efforts to meet the assessed criteria. Teachers can create rubrics independently or with their students, and rubric generators offer a set of prompts after which the system

creates a rubric that can be printed or accessed online. These generator sites usually also have a bank of prepared rubrics that teachers can select and use. ForAllRubrics also integrates a badge creator with its rubric software.

ClassDojo is an app that focuses on developing classroom community through management and assessment of customizable student behaviors, such as skills, values, or learning accomplishments, that should be assessed using rubrics developed by the teacher with students. It also supports teacher–parent and student–parent communication with sharing tools.

TEST GENERATORS Teachers use **test generators** to create tests built from a test bank of questions or teacher-created questions, and then the program prepares the test for print or, with some software, for online testing. The features of test generators vary, but the following common ones offer several advantages even over word processing programs:

- **Test creation and revision procedures**—Test generator software produces tests in a standard layout; the teacher need not worry about arranging the spacing and format of the page. The software prompts teachers to create tests item by item in formats such as multiple choice, fill in the blank, true/false, matching, short answer, and essay. It can also include multimedia, image, audio, and video content. Changes, deletions, and updates to questions are easy for teachers to accomplish without concern for page format.
- **Random generation of questions**—Test items can be selected randomly from an item pool to create different versions of a test. This is especially helpful when a teacher wants to prevent “wandering eye syndrome” as students take a test.
- **Selection of questions based on criteria**—Programs usually allow teachers to specify criteria to address when generating a test. For example, items can be requested from a specific content area, matched to certain objectives, or set up in a certain format, such as short-answer items only.
- **Answer keys**—Most programs automatically provide an answer key at the time the test is generated. This is helpful with grading, especially if different versions of the test are used.
- **Test item banks**—Many test generators allow the use of existing question pools, or **test item banks**, and some offer these banks for purchase in specific content areas. Some programs also import question banks prepared on word processors.

MULTIMEDIA-BASED E-ASSESSMENT Many teachers are using Google Forms and an add-on app, Flubaroo, to build their own e-assessments that can include images, video, and text. This type of generator provides automatic grading, simple graphing, and the ability to email or embed the test in web sites, such as Google Classroom and Google Sites. Some software is content specific, such as Avenue, which is a system for building, assigning, evaluating, and archiving video-based language performances for learners of all world languages. StudyBlue facilitates crowdsourced flashcard development.

Computer-Based Testing Systems

Also known as **computer-assisted testing (CAT)**, computer-based testing systems allow students to take on-screen tests or to put test answers on optically scanned “bubble sheets.” These systems also provide reports on performance data afterward. More state tests, as well as the SAT and ACT, are now being administered by computerized testing systems. Many textbook, content, and software publishers are building computer-based

testing systems to complement the textbook content materials adopted by school systems or to provide supplemental content and testing.

Software that can assess each person's ability level can create shorter tests. The software continuously analyzes responses and presents more or less difficult questions based on the student's performance. This is known as **computer adaptive testing** (Barla et al., 2010). Computer-based testing of all kinds remains controversial, however. Some people feel that it is not equivalent to other kinds of tests and could cause increased test anxiety in some students (Fritts & Marszalek, 2010). Herold (2013) notes that there are controversies regarding the use of computer-based testing with students with disabilities.

Digital Portfolios

A **portfolio** includes a collection of a student's work products over time arranged so that the student and others can see how his or her skills have developed and progressed in relation to learning goals or outcomes. Many teachers are now using student **digital portfolios** or **electronic portfolios**, collections of work in a multimedia format on a website or other multimedia product as an assessment strategy for cumulative achievement. Most teachers emphasize student reflection in portfolios so learners build deeper understandings about their development. Reflective portfolios are more than just collections of materials. Teachers usually provide the structure and criteria for selecting and judging content and advise students how to place items in the portfolio. The range of digital resources for creating portfolios includes:

- **E-Portfolio software**—Portfolio software provides a ready-made structure to which teachers can add content instead of creating their own format. Software programs such as SeeSaw and DIGcation are e-portfolio systems.
- **Adobe Acrobat Professional**—Adobe Acrobat Professional has features that allow files that were created in different applications (e.g., documents, email messages, spreadsheets, videos, and presentations) to be combined in one Acrobat file. Students can add navigation with customized bookmarks, add interactive buttons, links, and multimedia. The resulting file is viewable in free Acrobat Reader.
- **Multimedia authoring software**—Teachers can structure portfolios with software such as Microsoft PowerPoint, Apple Keynote, and Prezi. This software allows embedded multimedia and defined interactivity for viewers.
- **Websites**—Portfolios can be posted on the web where they can be easily shared with others. These portfolios can include sophisticated video and audio presentations. Portfolios made with Google Sites can use any materials archived in a student's Google Drive and links to other materials.
- **Video**—Today's digital video offers flexible, interactive formats for displaying portfolio elements. Video elements to document teacher or student accomplishments can also be inserted into the multimedia products and websites described previously. YouTube, SchoolTube, and TeacherTube are video hosting sites that have some limited editing features.

The following five steps can support portfolio development:

1. **Determine portfolio requirements**—Teachers identify the evidence areas required, technological medium to use, and criteria to meet.
2. **Create the structure**—Teachers set up the portfolio structure on the medium (e.g., e-portfolio software, web, Acrobat).
3. **Add and link components**—Students collect or create evidence of learning and add to the portfolio by required deadlines.

VIDEO 4.7 Instructional Uses of Digital Portfolios

In this video, an assessment director talks about the role of digital portfolios in learning.



4. **Monitor the collection**—Students receive periodic feedback from teachers or others and add reflective ideas across time.
5. **Reflect on evidence areas**—Students add or revise evidence components as needed based on ongoing reflection and feedback.

Gradebooks and Student Information Systems

In the past, teachers have tracked student grades in spreadsheet software or in a gradebook program designed specifically for student names, test and assignment scores, teacher notes, and weighting information for specific assignments or tests. Gradebook programs automatically generate averages and weighted averages for each student and a class average for each assignment. Many school districts are beginning to adopt student information systems (SIS), which include a gradebook feature.

SIS are software tools that help educators track student, class, and school data (e.g., attendance, assignment and test scores, special education processes) to maintain records and support decision making. The systems can do any or all of the following:

- Track and report attendance
- Maintain records on student demographic data (e.g., birth date, address)
- Track and report achievement by objective
- Facilitate special education IEPs and Response to Intervention (RTI) processes
- Allow parents and students online access to student grades and attendance information via portal

Some SISs are expanding to include learning analytics capabilities and learning management systems (LMS) to provide integrated e-learning solutions. Figure 4.11 is an example screen from one such system.

Figure 4.11 Sample S
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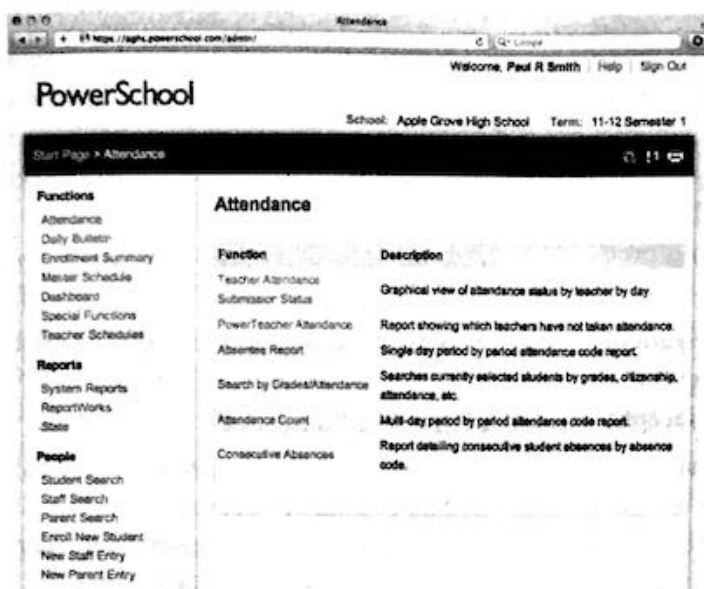
Chapter 4 Su

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Figure 4.11 Sample Screen from PowerSchool

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Check Your Understanding 4.7

Chapter 4 Summary

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

1. Technology productivity resources are configurations of hardware and software that support classroom productivity for teachers and students.

- Computing hardware configurations include a classroom innovation station, one-computer classroom, several classroom computers, mobile carts or COWs, computer laboratories, student-supplied hardware (BYOD), and school-supplied devices (one-to-one computing).
- Computing hardware configurations can support whole-class instruction, whole-class independent work, flipped learning, centers or stations, collaboration, and independent learning.
- Software resources for productivity include software suites, open source software, cloud-based software, mobile software (apps), and desktop software. This software does not contain curricular content but relies on students and teachers to bring content to productivity tasks.

2. Writing and publishing activities can be accomplished with word processing and desktop publishing software.

- Word processing and desktop publishing software can save teachers time, improve document appearance, and allow easy exchange and collaboration on written tasks. Uses of word processing and desktop publishing software include creating handouts, instructional materials, lesson plans and notes, reports, forms, letters to parents and students, flyers, and newsletters.
- Students learn writing processes, language, and multimedia production. Word processing and desktop publishing software can enable sharing and collaborating on written projects; engaging in language, writing, and reading exercises; writing across the curriculum; reporting research findings; and publishing creative works.
- Students and teachers should use effective design criteria relating to fonts, type size, type style, colors, graphics, and text formatting when engaging in digital writing and publishing.

- Research shows positive benefits of the use of word processing on writing, revision, and publishing, but writing strategy instruction is equally important. Examples of desktop publishing uses portray highly motivational, authentic projects.
 - Challenges related to word processing and desktop publishing software include the age at which students should start word processing, the necessity to teach keyboarding skills, the effects of word processing on handwriting and on assessment, and problems with inadvertent errors.
- 3. Representation software help teachers and students display information, including text, images, graphics, symbols, audio, and video to demonstrate concepts.**
- Teachers use representations to enhance the impact of spoken information, enable multimedia-rich content depictions, make content polished and professional, organize thinking about a topic, and create enduring learning artifacts. Uses include demonstrating content concepts, illustrating problems and solutions, presenting informational summaries, using multimedia assessment, and creating tutorials or game-based reviews.
 - Students create representations for collaboration on content learning and knowledge, book reports or research, creation of interactive storybooks, and multimedia products.
 - Students and teachers should design digital representations with considerations related to type size, text and background colors, amount of text, design simplicity versus complexity, graphics and clip art, and sounds.
 - Research indicates that effective content representations shown to students can engage and focus their attention on content learning, and students' digital drawing helps them to learn content concepts.
 - Challenges include a lack of focus on the message content, a lack of coherent visual design, and a tendency toward a linear, slide-based presentation format.
- 4. Data and analysis software such as online surveys; spreadsheets; statistical and database software; and**

charting, graphing, and visualization assist in data collection and making sense of numerical, textual, and other data.

- Teachers engage in data collection and analysis to prepare classroom materials, organize information, and complete calculations. Uses of these tools include polling students, performing calculations quickly, examining student data trends, and building visual teaching demonstrations.
 - Student productivity uses include collecting and analyzing data, testing hypotheses, finding publicly available data for analysis, visualizing data, and mathematical problem solving.
 - Research indicates that students comprehend abstract concepts better when they are engaged in data analysis or data visualization. However, students and teachers have low data literacy skills that need emphasis in K-12 education.
 - Challenges include limited teacher proficiency with data and analysis content; difficulty in establishing hands-on, project-based, real-world data activities; and overestimation of students' technological and data skills.
- 5. Planning and organizing software help teachers and students to organize for more productive use of their time and students to conceptualize and communicate their ideas.** These tools include lesson-planning software, scheduling/time management tools, and outlining and concept mapping software.
- 6. Materials generators help teachers produce instructional materials.** Materials generated relate to web design software, whiteboard activity software, worksheet and puzzle generators, IEP generators, graphic document makers, and PDF and forms makers.
- 7. Assessment software help teachers implement formative and summative assessment of student progress.** These tools include student response systems, rubric and test generators, digital portfolio systems, gradebooks, student information systems (SIS), and computer-based testing systems.

Technology Integration Workshop

1. Apply What You Learned

In this chapter, you read and learned about technology productivity resources for teachers and students. Now apply your understanding of these concepts by completing the following activities:

- Reread Ms. Kiley's lesson in Technology Integration in Action: *Can You Afford a Car?* at the beginning of this chapter. Pay close attention to Step 3 of her TTIPP when she identifies the technological possibilities for her problem of practice: engaging students to develop

financial loan literacy in Using your knowledge introduced in this chapter (4.6-4.12), generate at least one activity that demonstrates the possibility for targeting Ms.

- Review how Ms. Kiley used her TTIPP as represented in the Matrix to analyze the role that your new technology (from the last step) would play in reflecting on the roles your possibilities play as replacing a transformation of instructional curriculum. Do you feel your technology would provide rela-

2. Technology Integration Evaluating Lesson

Complete the following evaluation: Technology Integration Example 2. Find one on the Internet, or one

- Locate lesson ideas—1. Focus on any of the topics about in this chapter, for example:
 - Writing or publishing
 - Representing concepts
 - Data, analysis, and
 - Organizing ideas and
 - Assessing student progress
- Evaluate the lessons—1. Use the Evaluation Checklist at the end of each of the lessons you choose and your RATification to evaluate these lessons in the future.

3. Technology Integration Creating Lesson Plan

Review the way to implement (Figure 2.6) for technology in

financial loan literacy in the context of buying a car. Using your knowledge about productivity resources introduced in this chapter (review Tables 4.3, 4.4, and 4.6–4.12), generate at least one new technological possibility for targeting Ms. Kiley's problem of practice.

- Review how Ms. Kiley RATified her lesson in Step 5 of her TTIPP as represented in Figure 4.1. Use the RAT Matrix to analyze the role(s) and relative advantage that your new technological possibilities (identified in the last step) would play in the lesson. You must reflect on the roles 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 4.1–4.11, any lesson plan you find on the Internet, or one provided by your instructor.

- a. Locate lesson ideas—Identify three lesson plans that focus on any of the tools or strategies you learned about in this chapter, for example:
 - Writing or publishing
 - Representing concepts, ideas, and knowledge
 - Data, analysis, and visualization
 - Organizing ideas and concepts
 - Assessing student progress
- 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 the way to implement the TTIPP Model (see Figure 2.6) for technology integration planning and use Ms.

Kiley's lesson in the Technology Integration in Action: *Can You Afford a Car?* section of this chapter as a model. Create your own technology-supported lesson that uses technology device and software resources for teacher and/or student productivity by performing 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 to determine any needed revision?
 - 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.