



Illustration by James Yang

Using Flexible Technology

to Meet the Needs of Diverse Learners:

WHAT TEACHERS CAN DO

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Ms. G. is starting the school year with 32 fifth graders whose learner profiles reveal a wide range of preferences, skills, and abilities. For example, Maria is a recent immigrant whose first language is Spanish and whose English skills, particularly in reading, are still quite low. Ray is extremely curious and creative but has a hard time taking notes and writing. Josh is interested in aviation and science but is still reading at a third-grade level. Sam is writing for the school newsletter and complains of being bored. And Elena has a slight visual impairment that requires her to be seated in front so she can see the board. The learner profiles of other students in the class reflect similar diversity of learning strengths and needs. As Ms. G. ponders how she will go about meeting the wide-ranging needs of these incoming students, her eyes light on the four computers that sit at the back of the room.

DIVERSITY IN THE CLASSROOM

Although Ms. G. and her class are fictional, they accurately represent the reality of the mixed-ability general education classroom. Having a combination of students whose academic skill levels can range from several years below grade level to several years above is nothing new for many K-12 teachers. But the diversity of learning needs in today's general education classroom continues to grow. For example, the number of English learners in public schools has swelled dramatically, growing by over 30 percent from 1994 through 2000 (USDE, 2004). So too have grown the numbers of students with special needs who spend 80 percent or more of the school day in a general education classroom (USDE, 2002). Yet, while 80 percent of general educators have a special education student in their classroom, just 45 percent say they feel "very prepared" to teach these students (Ansell, 2004).

With *No Child Left Behind (NCLB)* holding schools accountable for how all students learn, schools and their teachers must ensure that every student has access to the standard curriculum. Publishers, researchers, and other curriculum developers are working to create curricular materials that meet the needs of a diverse student population, but it will be some years before these are available in all classrooms. Meanwhile, teachers like Ms. G. don't have time to wait. They must act now to meet the needs of mixed-ability classrooms, and many are turning to differentiated instruction. Some common classroom technology can support them in this effort. This brief explains how.

DIFFERENTIATED INSTRUCTION

That different children learn differently is not news to parents or teachers. In recent years, brain research has yielded more about why and how this is true, measuring differences in terms of an individual's abilities to encode visual, auditory, and other types of information. Taking a differentiated approach to instruction means accommodating these differences by tailoring teaching

to students' strengths and knowledge. Teachers can do this by providing materials and tasks of varied levels of difficulty, along with supports, to multiple instructional groups, and by allowing students to work at least part of the time in modes that are most successful for them (e.g., alone or collaborative, auditory or visual, practical or creative) (Tomlinson, 2001). Tomlinson defines differentiating instruction as giving students multiple options for taking in information, for making sense of ideas, and for expressing what they learn. In other words, a differentiated classroom provides different avenues for students to acquire content, process ideas, and demonstrate their understanding.

TECHNOLOGY SUPPORTS FOR DIFFERENTIATION

Many of the technology resources that most schools already have at hand can be used to facilitate this kind of tailored instruction. Simple graphics software and word processors, as well as resources and tools found on the Internet, offer students a variety of ways to access content, work with information to develop understanding, and demonstrate what they know. Yet the power of this readily accessible technology may not be obvious to all teachers or to those at the site or district level who make decisions about allocating technology, professional development, and other resources. They may be familiar with some low-tech strategies for enhancing learning, such as books on tape, highlighting, worksheets and writing templates, and making diagrams, charts, or tables, but not realize that such strategies can be improved with the use of existing digital technology. They may have no idea that some useful strategies are only possible — or practical — through the use of digital technology.

Over the past five years, the WestEd Regional Technology in Education Consortium (RTEC) has worked to make technology's benefits more accessible for all learners in the western region. Working with the Alliance for Technology Access, RTEC has emphasized best practices

using technology to serve all students.¹ One result has been the creation of related professional-development materials on how to use technology with diverse student groups. These materials are now available on a Web site called Technology Tips for Diversified Instruction. Drawing from that Web site, this *Knowledge Brief* introduces a few of the strategies for getting the most out of standard technology when working in mixed-ability classrooms. The intent is to give school site committees, administrators, and others a taste of the possibilities. Details and more tips on adjusting content, the ways in which students receive or work with that content, and the means by which students can show what they know are available at <http://www.westedrtec.org/techtips>, along with handouts that can be used for staff development.

Tools Available Today: What Teachers Can Do

After considering the standardized curriculum and what she knows about each of her students, Ms. G. looks more closely at the computers to make sure they are connected to the Internet. She finds that they have also been loaded with three software programs: Kid Pix, Kidspiration 2, and Microsoft Word. She's familiar with these programs through some site-based staff development, and has used word processing with the class. She wants to go further and wonders if the Internet connection and the programs might assist her in meeting the needs of her students.

The answer is yes. A modern computer connected to the Internet and running standard software provides a wide array of features, as well as access to a vast amount of information. This brief highlights just four areas: talking text, Web resources, graphic organizers, and features of the word processor. These functions are readily available in most classrooms and can be leveraged to

meet the needs of diverse learner groups. Each allows flexible adaptations or alternatives to support ways in which students interact with curriculum.

TALKING TEXT

Many teachers are surprised to find that popular software packages such as Kid Pix 3, Appleworks, Inspiration/Kidspiration 2, and StoryBook Weaver Deluxe have tools, buttons, or menu selections that allow text to be read aloud electronically. The latest Macintosh operating system (OSX) provides speech, and a number of free or very low cost utilities that read aloud highlighted text can be downloaded for Windows.

Making Talking Text Work for Students. In a single class, the text-to-speech functionality can assist a variety of students, including those who are motivated by more advanced materials but are frustrated by reading comprehension difficulties; those (including English learners) who will profit from the reinforcement of both print and oral reading; and those who hate to read but are willing to listen. It can be used with a whole class, with groups, or with individual students for previewing new information or as part of a final proofreading exercise. Kindergarteners can listen to individual letters and work in an exploratory fashion. Talking text is an important additional tool for supporting comprehension for some students, and several research studies have identified its promise for helping students with reading disabilities comprehend written materials (National Institute of Child Health and Human Development, 2000). Literature packages for elementary and middle schools from Houghton Mifflin, Open Court, and others suggest inclusion and/or differentiation through audio access to text.

¹The research on using technology for differentiated instruction is far from complete. The bulk of this research has focused on using technology to support reading and writing. The National Reading Panel concluded from a small number of studies that the addition of speech to print presented on computers may be a promising alternative and that some students can benefit from the use of computer technology in reading instruction. A good discussion of the research on using technology to support reading instruction can be found in *Technology and Teaching Children to Read* from NEIRTEC, available at http://www.neirtec.org/reading_report.

Ms. G. realizes that text-to-speech can help a number of her students, as part of the classroom's writing center. If Ray does his writing on the computer and uses the talking text function, he may be able to hear the grammatical errors and create better sentences. Hearing the words while also looking at them highlighted on the screen may help Maria in learning English. Josh can get auditory access to the science facts that he loves by having information read to him from NASA Quest and other Web sites, even though the actual reading level of the sites is beyond him.

During the first week of school, the class is doing a lot of silent reading, but Ms. G. soon realizes that Josh and Maria are falling behind. She has found that most of the literature the class will be reading is available in electronic text format through a Web site, so she asks Josh and Maria to move to the computers, where they don headphones and open text files of the chapter the class is reading. Ms. G. tells them to try two different strategies. The first is to highlight and listen just to the words they do not know. The second is to listen to an entire paragraph and then read it silently to themselves. Ms. G. also shows them how to highlight a word and call up a dictionary definition in case they don't recognize a word after hearing it. She asks them to record the words they look up on sticky notes, so that they can discuss them with her during direct word study time. Over the next month, Josh and Maria find each strategy helpful, depending on their energy level and the degree of challenge presented by the material. She later notices Josh and another student using talking text with a Web site on Black Holes at www.kidsastronomy.com.

WEB RESOURCES

An expanding world of content, including historical documents, literature, articles, reference works, maps, charts, graphs, timelines, and textbooks, can be found on the Internet. These resources include many materials with high student interest, such as articles on snowboarding, sports, and popular media figures. For teachers who are just beginning to use technology, the Web offers a wealth of tools, activities, and resources that just need to be located.

Finding Useful Electronic Resources. Finding online books and text has become increasingly easy thanks to the creation of indices designed specifically for teachers, as well as searchable collections of books and documents. Some options are listed below, and a more complete handout can be downloaded from <http://www.westedrtec.org/techtips>. A number of these sites can be searched by keyword, subject, or grade level. KidsClick and Marco Polo provide pre-selected Web-based materials. American Memory narrows a teacher's search to historical source documents. Searching digital libraries yields an idea of the great range of materials currently available. These libraries provide books and other materials in an increasing number of formats, including MP3 audio file versions.

KidsClick (Web resources organized by subject, with estimated reading level)
<http://sunsite.berkeley.edu/KidsClick!>

Marco Polo (lesson plans and related electronic text organized by topic, subject, and grade level)
<http://www.marcopolo-education.org>

American Memory (historical documents from the Library of Congress)
<http://memory.loc.gov>

University of Virginia's e-Book Library
(1800 e-books – can browse by subject)
<http://etext.lib.virginia.edu/ebooks/ebooklist.html>

Benetech's BookShare (Over 12,000 titles of books still in copyright, available for a modest subscription rate)
<http://www.bookshare.org>

Enhancing Electronic Resources. Teachers who are already somewhat technology savvy can manipulate and enhance Web-based resources to better meet students' needs. The materials can be printed out for classroom use or used electronically. They can be edited and changed to fit with different lessons or students. As an example of the flexibility offered with digital text, consider the variety of ways in which a teacher could make use of Martin Luther King, Jr.'s "I Have a Dream" speech, which is available on the Internet:

- Text-to-speech options can be used to read the entire speech as a preview or to read individual words.
- The text can be changed visually, by altering the size and color of the font or by adding more space between lines.
- Words and phrases can be underlined, bolded or highlighted in order to draw attention to certain facts or new vocabulary. Students can make these changes to indicate understanding, as part of assessing prior or acquired knowledge or skills.
- The text can be reorganized to create a summary or an outline view.
- The text can be placed in a box on one side of the page with room on the other for student notes or questions.
- Questions for students to answer or background information can be inserted close to the relevant section of text.
- Text can be broken into manageable chunks, with generic prompts inserted to remind students to apply a strategy (e.g., summarizing, predicting, questioning, clarifying, visualizing).
- The speech can be enhanced with a picture of Dr. King, an audio clip of the first few lines of the speech, a timeline of the civil rights movement, or other graphics.
- Students can copy and paste words they don't know into an online dictionary, which will also read them aloud.

- Students can work with the text to produce their own summary or interpretation of the speech.
- Once enhanced, the same documents can be used repeatedly, with or without further modification.

GRAPHIC ORGANIZERS

A graphic organizer is simply a visual representation of ideas or information. Calendars and maps are common examples of a graphic organizer. Such organizers are particularly suited to

- assessing understanding or diagnosing misunderstanding,
- increasing recall,
- designing a complex structure (e.g., long texts, large Web sites),
- communicating complex ideas, and
- incorporating both images and text.

Using Computer-based Graphic Organizers. Generating graphic organizers electronically, using specialized software such as Kidspiration 2/Inspiration, graphics software such as Kid Pix, or even the graphic elements in Microsoft Word, offers distinct advantages. For instance:

- Color-coding is possible and can be easily changed as a map or diagram evolves.
- Elements of a mind map or chart can be moved around as relationships between ideas evolve.
- Graphic elements such as pictures and arrows can be added to reinforce vocabulary, relationships, and meaning.
- Some software allows switching from a graphic mode to an outline mode.
- Text can be highlighted and read aloud by the computer.
- Work can be saved for further refinement in a later session.
- A graphic organizer can be printed out so that each child has a hard copy from which to work.

Many teachers may be familiar with a type of graphic organizer called a rubric, which is created to convey the objective criteria for grading a project. Sharing rubrics with students conveys the expectations for beginning, proficient, and expert achievement in building a diorama, writing a paper, or designing a slideshow. Teachers who make electronic rubrics can store them for easy modification, as well as share them with other teachers through Rubrican, Awesome Library, and other educational Web sites.

Early in September, Ms. G. wants to see what the children remember about California history, to develop context for their study of the Pueblo tribes of the Southwest. She uses one of the computers with Kidspiration 2 to gather all their knowledge on the topic. This map of facts helps the class organize the information into a “KWHL chart,” with columns for What We Know, What We Want to Find Out, How We Are Going to Find Out, and What We Have Learned. Before printing out the charts, Ms. G. does a little bit of editing to make three versions of the chart. Recognizing that students are starting off with different levels of beginning knowledge, she wants to ensure that she presents an appropriate level of challenge for all students. She also remembers she can print a copy in large print for Elena. Several of the students will be writing their paper using the computer, so she also exports the Kidspiration 2 data into a word processor as an outline for their writing. Ms. G. has used Word with her students in the past and now she wonders if the software has features that would enhance the writing process further.

STUDENTS CAN READ
EACH OTHER'S WORK AND
ADD BOTH COMMENTS
AND QUESTIONS.

WORD PROCESSORS

Most word processors have a number of features that can assist both teachers and students. The most commonly available is Microsoft Word, which will be discussed here, but many of the same features are shared by AppleWorks, WordPerfect, and other programs. Easy changes made possible by word processors include simply increasing the font size or using color to highlight specific words, such as prepositions or adverbs, facts, or other text elements. Making something a little bigger and printing it out can make an impact.

Reinforcing Grammar and Spelling. Most who use Word are familiar with the red underlining that signals misspelled words when the spell-checker is turned on. The underlining provides a clear visual cue, and many students attempt to correct the spelling before turning to the computer-generated suggestions. Word's grammar checker underlines questionable passages in green and can be a source of frustration to many people, but its utility is greatly enhanced when you tell it what to look for.

The program allows users to individually select or de-select 26 different types of errors. Activating just punctuation and capitalization might be more helpful with younger children, while turning on only passive sentences, possessives and plurals, or subject-verb agreement could be more helpful with older students.

Adding Comments. Because Word allows users to easily add comments to text, students and teachers can add information or questions that are then revealed by highlighting the selected words. The comments are hidden until a user selects them. This feature enables teachers to produce a version of an article or story with extra support for certain readers. Comments at the

end of each paragraph can prompt students to think about the point the author has made, to make notes, to add information to a compare/contrast chart, or to relate the story to their own experiences. Students can read each other's work and add both comments and questions. Comments are not limited to written text; pictures and spoken audio can also be pasted into the comment section.

Gauging Readability. A final Word tool worth mentioning is the readability score, offered as an option in the spelling checker. Word presents the Flesch-Kincaid Reading Grade Level, along with a "Reading Ease" score and the number of passive sentences. (Reading level is based on the average number of syllables per word and words per sentence.) Teachers can use this to check the reading level of electronic text, as well as the level of students' writing. Older students may find it useful to check their own compositions.

Ms. G's class has finished reading Dear Mr. Henshaw by Beverly Cleary and is now working on a related project to gather information about the Monarch butterfly. The Monarch Watch Web site has the best resources, but Ms. G. is not sure about the reading level. She pastes an article on butterfly migration into Word and discovers the reading level is mid-8th grade, which makes it accessible to some, but not all of her students. She believes she can make the article more accessible to more students by adding some explanatory comments. For example, the word "temperate" needs a more context-specific definition than the one found in the dictionary. She decides that a picture of a world map with the temperate zones is needed along with an explanation. Wikipedia, an online encyclopedia, has such an entry so she pastes a link to this page in her comment. Ms. G is excited about the resources she is finding and asks two of the other fifth grade teachers if they'd like to see how she's using technology to customize learning materials.

Technology Supporting Research-Based Instructional Strategies

Technology can support a number of research-based strategies. A meta-analysis of more than 100 research reports on instruction (Marzano et al., 2001) identified the nine most effective instructional strategies. Most of them can be facilitated or even improved using technology (Brabec, 2004). For example:

- Identifying similarities and differences was the most successful instructional strategy. Word processors, graphics software such as Kid Pix, or graphic organizers such as Kidspiration 2 allow you to build charts, tables, and graphs that express classification and comparison. These can all be done using paper and pencil but the computer offers flexibility for the student who needs to hear it, needs to see it in color, or needs to interact with it.
- Summarizing and note taking are ways in which students identify and prioritize information. Software like Inspiration and Word can be used to make and customize templates that can be easily adapted to meet the needs of different students. For example, you can add more or less information to an outline for note taking or report-writing. A number of approaches to summarization and note taking can be modeled, and easily adapted, if the text is computer-based.
- Cooperative learning is supported by a number of technology applications. For instance, roles can be assigned that include computer tasks such as typing and mousing. Web Quests and creating computer-based slide shows or other multimedia presentations work well as group activities structured with cooperative roles.
- Nonlinguistic representation is based on the idea that knowledge is stored in two forms — linguistic (words) and imagery (mental pictures). Graphic organizers, multimedia, and image-filled Web sites provide these dual channels to increase retention and learning.

What Schools and Districts Can Do to Support Technology Use

Administrators and technology committees can help teachers extract full value from existing software to support teaching and learning. An investment in appropriate professional development is needed for the successful implementation of these tools. Teachers also need time to think about how to integrate technology resources into their classroom in a way that fully supports instruction. Some models that have worked include:

- offering several one-hour training sessions, to give teachers adequate time to explore existing software features, to plan how to integrate them, and to share their ideas with colleagues;
- providing a few hours of teacher release time specifically for technology-related preparation, either solo or with another teacher or with a mentor;
- finding mentors within the district, including inclusion specialists or other special education staff who may already have expertise in using technology to customize curriculum and instruction and who can share their knowledge with general educators;
- encouraging staff to contribute technology tips at staff meetings in order to share strategies that are a good fit with your curriculum;
- asking in-house and visiting technology staff developers to address the needs of diverse learners whenever they provide training at your site;
- when purchasing new software and curriculum, looking for features that can support a mixed-ability classroom, such as text-to-speech, color-coding, adjustments for different ability levels, and graphic options.

If you need guidance for planning implementation, visit the WestEd TechPlan Toolkit at http://rteceexchange.edgateway.net/cs/rtecp/view/rtec_str/9.

It is also important to consider who can make changes to lab or classroom computers; if new software needs to be added to provide text-to-speech capabilities, can individual teachers do this or does it require the support and consent of a lab or technology coordinator?

What the Future Holds

Ms. G. has seen the benefits of technology for her students but she wishes the tools were more integrated. She hopes that talking text will soon be a seamless option for students using the Internet, doing word processing, or using any other application. She imagines a day when the textbooks and their related instructional materials are available not just in hard copy, but also on the Internet and on a CD. She would like access to supplementary and enhanced content based on the needs of her students, so that Maria could find word definitions designed for the English learner, Ray would receive assistance in taking notes, and Sam would be supported in moving through the curriculum as quickly as he wanted. She dreams of being able to adjust the reading difficulty and level of supports to match a student's current abilities. She imagines one-click access to video clips that match the curriculum, with subtitles available in a number of languages. She'd like the computer to be a stronger partner in helping to collect and analyze data about what her students know and what they are learning, helping her to meet students' changing needs.

PRESSURE TO CHANGE

Given the current trend in legislative and consumer pressure, teachers like Ms. G. are going to see an increase in the number and flexibility of electronic curriculum resources over the coming decade. The push for flexible technology and curriculum materials is coming from many levels. Some of the demand relates to access for people with disabilities. Section 508 of the Americans with Disabilities Act, first enacted in 1986, required the government to make all

information technology and Web sites accessible. These requirements are being replicated in state government and in some states, are being applied to K-12 schools. For instance, educators in Maryland need to consider the accessibility of all software either purchased or designed by teachers (Hendricks et al., 2003). California recently adopted regulations (Ed. Code 60061.8) that will require publishers of adopted curriculum to ensure the accessibility of software materials and Web sites over the next 10 years. There is even pressure for change due to the weight of student backpacks. Legislation adopted in California and Tennessee, along with pending legislation in six more states, sets weight limits for textbooks. Some of these bills require the exploration of the Internet and CDs as an alternative.

Today's publishers likely already have textbooks in electronic format, but the format for printing is very different from a plain-text format that can be used to generate Braille or large print, or a format that can be shared via the Internet. Barriers to electronic textbook access are being eliminated through the adoption of a National Instructional Materials Accessibility Standard, created by representatives from consumer groups, government, educators, and textbook publishers and endorsed in July 2004 by the U.S. Department of Education. These voluntary standards are designed to guide the production and electronic distribution of flexible digital instructional materials, enabling textbooks to be provided to students in Braille, text-to-speech, and other accessible formats. Currently, audiotapes or audio CD versions of literary textbooks are commonly offered by publishers; the new standards will enable schools to obtain an electronic version as well. Research on creating other fully accessible forms of educational media (e.g., online

learning systems, Web sites, video) is being conducted by WGBH's National Center for Accessible Media.

TEXTBOOK PUBLISHERS GO ONLINE

Publishers are already moving to put more content online. Glencoe, Harcourt, Holt Rinehart and Winston, McDougal Littell, Macmillan/McGrawHill, Prentice Hall, and others offer online or CD-based supplementary materials that include valuable tools. These are worth exploring for their relevance to the mixed-ability classroom. Some offer Web versions of textbook curriculum with additional background, contextual videos, text summaries, visual summaries, and reading strategies, such as questions presented near relevant text passages. Companion CDs may offer software that enables students to use an electronic highlighter on passages they have read and to obtain audio support for pre-selected vocabulary words, definitions, and summaries. A number of companies are developing partnerships to bring educational content to handheld computers.

UNIVERSAL DESIGN
CALLS FOR ALL
COMPUTER-BASED
LEARNING MATERIALS TO
BE FLEXIBLE ENOUGH TO
SUPPORT ALL LEARNERS.

ACHIEVING UNIVERSAL DESIGN TO MEET THE NEEDS OF ALL STUDENTS

Despite strong indications that technology can help meet the needs of diverse groups of students, the potential remains unavailable to many teachers and students, lost in features that very few people know about or the immensity of the Internet. A growing number of products model many of the possible channels of access and interaction. But some consumer groups, curriculum developers, and educators are advocating "universal design," a vision that calls for *all* computer-based learning materials to be flexible enough to support *all* learners. For instance, in developing math software, a

Universal Design Features

Some additional examples of software that include universal design features:

The Digital Field Trip to the Rainforest- AT version, <http://www.digitalfrog.com>

Thinking Reader, <http://www.tomsnyder.com>

IntelliMathics or *IntelliTalk*, <http://www.intellitools.com>

Solo or *Access to Math*, <http://www.donjohnston.com>

A Web site exploring universal design examples of enhanced text for elementary school students is the *Intersect Digital Library*, <http://intersect.uoregon.edu>

For more information on universal design, visit the federally funded Universal Design for Learning site, and the Teaching Every Student site at <http://www.cast.org>.

number of universal design features would help ensure that the program benefits the widest range of students. When choosing software, educators might want to look for these features, asking whether

- the speed, number of problems, and instructional levels can be modified (some students are motivated by the necessity of a speedy response while others become frustrated under time pressure);
- students can modify the number of problems to be done before they get feedback;
- the software provides clues to the correct answer, instead of just saying the student is wrong; and
- the software includes built-in instructional aids such as counters, number lines, base-ten blocks, hundreds charts, or fraction strips that can give the student tools for representing a given problem in different ways (Babbitt, n.d.).

Greater use of universal design would free teachers like Ms. G. to focus less on the details of identifying and implementing supportive technology for diverse learners and more on the learners themselves.



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www.westedrtec.org/techtips

Technology Tips for Diverse Instruction is a project of WestEd's Regional Technology in Education Consortium (RTEC). As part of the Comprehensive School Assistance Program, WestEd's RTEC provides resources, professional development, and technical assistance promoting the effective use of technology in education with special emphasis on meeting the needs of educators and learners, especially in low-performing schools.



For more information about the Technology Tips project, contact Julie Duffield at 415.615.3213 or, by email: jduffie@wested.org.



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