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Graphic Organizers and Implications for Universal Design for Learning: Curriculum Enhancement Report

Curriculum Enhancement Report

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Graphic Organizers and Implications for Universal Design for Learning: Curriculum Enhancement Report

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Introduction

One way to help make a curriculum more supportive of students and teachers is to incorporate graphic organizers. Graphic organizers come in many types and have been widely researched for their effectiveness in improving learning outcomes for students with and without disabilities. This paper examines the research on educational applications of graphic organizers in grades K-12 and explores points of intersection with Universal Design for Learning (UDL), a curriculum design approach intended to lower the barriers that traditionally limit access to information and learning for many students. UDL is a theoretical approach that is based on research on the brain and effective teacher practices. UDL provides a framework for seizing the potential of digital technologies such as graphic organizers and using it to make the curriculum more flexible and supportive of diverse learners.

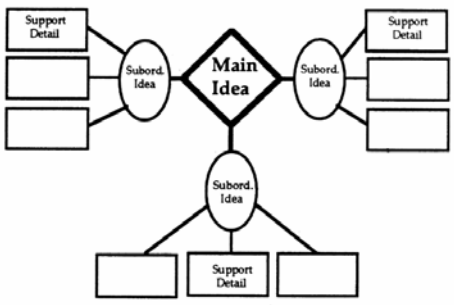
This paper begins with an introduction to graphic organizers (a definition, a sampling of different types, and a consideration of their curriculum applications) and a discussion of the research evidence for their effectiveness. The literature review addresses important questions about graphic organizers that are relevant to classroom practice, including whether graphic organizers are beneficial to students with disabilities and what instructional context makes them most effective. In the second part of the paper the discussion transitions to UDL applications of graphic organizers. This section develops an understanding of UDL and proceeds to identify ways that graphic organizers can support UDL at both the theoretical and teacher practice levels. The paper concludes with general guidelines for UDL implementation and a list of Web resources that provide further information.

The literature review in this paper is also available as a stand alone document, with annotated references. Look for it within the listing of Phase II Curriculum Enhancements Literature Reviews on the Enhancements Literature Review page of the National Center for Accessing the General Curriculum's Web site.

Definition

A graphic organizer is a visual and graphic display that depicts the relationships between facts, terms, and or ideas within a learning task. Graphic organizers are also sometimes referred to as knowledge maps, concept maps, story maps, cognitive organizers, advance organizers, or concept diagrams.

Descriptive or Thematic Map



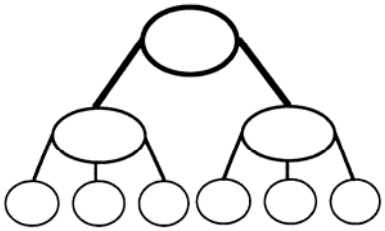
Types of Graphic Organizers

Graphic organizers come in many different forms, each one best suited to organizing a particular type of information. The following examples are merely a sampling of the different types and uses of graphic organizers.

A **Descriptive or Thematic Map** works well for mapping generic information, but particularly well for mapping hierarchical relationships.

Organizing a hierarchical set of information, reflecting superordinate or subordinate elements, is made easier by constructing a **Network Tree.**

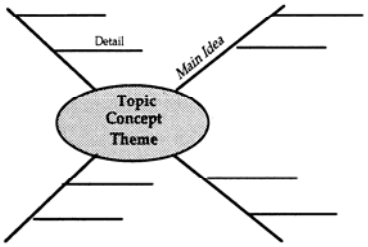
Network Tree



When the information relating to a main idea or theme does not fit into a hierarchy, a **Spider Map** can help with organization.

When information contains cause and effect problems and solutions, a **Problem and Solution Map** can be useful for organizing.

Spider Map



A **Problem-Solution Outline** helps students to compare different solutions to a problem.

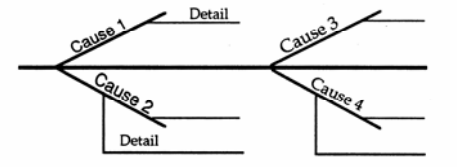
A **Sequential Episodic Map** is useful for mapping cause and effect.

When cause-effect relationships are complex and non-redundant a Fishbone Map may be particularly useful.

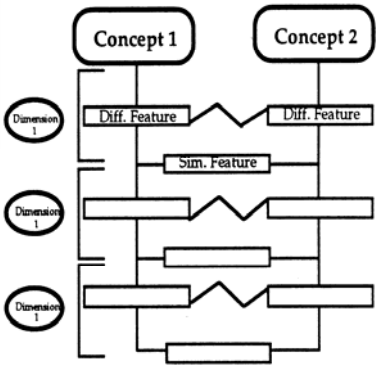
A **Comparative and Contrastive Map** can help students to compare and contrast two concepts according to their features.

Another way to compare concepts' attributes is to construct a **Compare-Contrast Matrix**.

Fishbone Map



Comparative and Contrastive Map

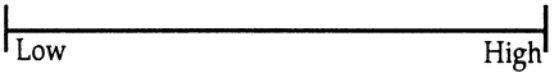


Compare-Contrast Matrix

Attribute 1		
Attribute 2		
Attribute 3		

Continuum Scale is effective for organizing information along a dimension such as less to more, low to high, and few to many.

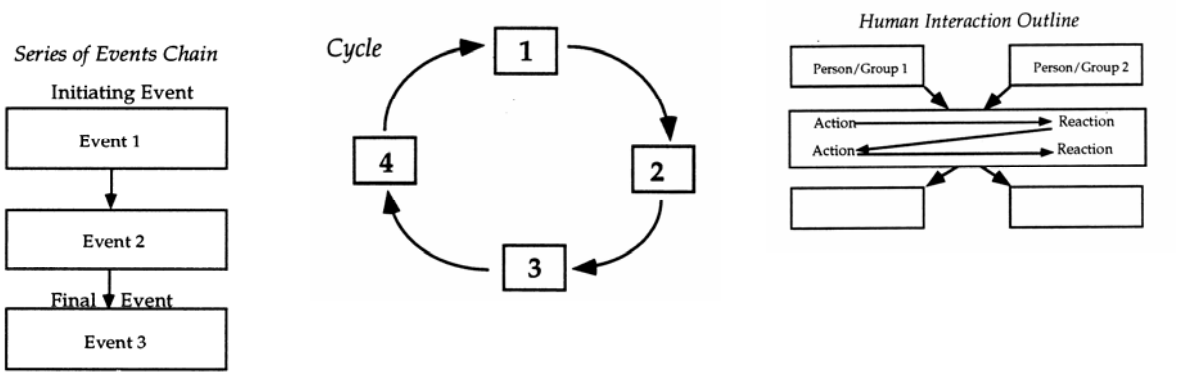
Continuum Scale



A **Series of Events Chain** can help students organize information according to various steps or stages.

A **Cycle Map** is useful for organizing information that is circular or cyclical, with no absolute beginning or ending.

A **Human Interaction Outline** is effective for organizing events in terms of a chain of action and reaction (especially useful in social sciences and humanities).



Applications Across Curriculum Areas

Graphic organizers have been applied across a range of curriculum subject areas. Although reading is by far the most well studied application, science, social studies, language arts, and math are additional content areas that are represented in the research base on graphic organizers. In these subject areas, graphic organizers have been shown to have benefits that extend beyond their well established effects on reading comprehension (Bulgren, Schumaker, & Deshler, 1988; Darch, Carnine, & Kammenui, 1986; Herl, O'Neil, Chung, & Schacter, 1999; Willerman & Mac Harg, 1991). Operations such as mapping cause and effect, note taking, comparing and contrasting concepts, organizing problems and solutions, and relating information to main ideas or themes can be broadly beneficial.

Evidence for Effectiveness as a Learning Enhancement

Before investing in a new technology or instructional approach it is important to know for certain that there will be a sizeable return on the investment. Research studies are designed to put instructional tools and instructional methods to the test, evaluating their effectiveness and exploring the conditions that impact their use (Figure 1). As such, research studies are an invaluable resource. In the following sections, we discuss the evidence for the effectiveness of graphic organizers based on a survey of the research literature.

Questions that Research Studies Can Answer for Educators

What aspects of learning and achievement can this enhancement improve?
How big an effect does this enhancement have on learning and achievement?
How does the effectiveness of this enhancement compare to other approaches?
Is this enhancement effective for students with special needs?
Can this enhancement normalize the performance of students with special needs to that of other students?
For what grade level of student is this enhancement effective?
Are their gender differences in the impact this enhancement has on learning and achievement?
How much experience with an enhancement do students need in order to reap benefits from it?
Is this enhancement engaging for students?
What kind of instructional context(s) are best suited to this enhancement?
What classroom settings are best suited to this enhancement?
How much teacher training and support is needed to implement this enhancement effectively?
How long do the effects of working with this enhancement last?
Do the effects of working with this enhancement generalize to other situations?

Figure 1. A list of teacher-relevant questions that research studies can address for any enhancement.

There is solid evidence for the effectiveness of graphic organizers in facilitating learning. Ten of the 12 studies investigating effects of graphic organizer use on learning reviewed here reported some positive learning outcome. We focus this overview on two main areas: comprehension and vocabulary knowledge.

The Effectiveness of Graphic Organizers for Improving Comprehension

By far the most frequently investigated learning measure in the studies we reviewed is comprehension. Of 12 studies, 9 reported that graphic organizer use elevated comprehension. These studies included a variety of comprehension measures (Figure 2). The reliability of these improvements in comprehension is further supported by Moore and Readence's (1984) metaanalysis. When looking across 23 different studies they found a small but consistent effect on comprehension.

Reading Comprehension Measures Shown to Improve Following Graphic Organizer Use

- Stanford Diagnostic Reading Test (Boyle & Weishaar, 1997)
- Comprehension questions (Boyle & Weishaar, 1997; Darch et al., 1986; Gardill & Jitendra, 1999; Idol & Croll, 1987; Sinatra et al., 1984)
- Concept acquisition test (Bulgren et al., 1988)
- Teacher-made tests (Bulgren et al., 1988; Willerman & Mac Harg, 1991)
- Written summaries (Gallego, Duran & Scanlon, 1989)
- Story grammar tests (Gardill & Jitendra, 1999)

Figure 2. Research studies have demonstrated improvements in numerous measures of reading comprehension when graphic organizers are used to support learning.

Although 3 studies reported no effect of graphic organizer use on comprehension, these findings appear to be attributable to deficiencies in experimental design. Carnes, Lindbeck, & Griffin (1987) reported no effect of advance organizer use relative to non-advance organizer use on the comprehension of microcomputer physics tutorials. However, students in this study were not trained to use the advanced organizers. This same factor may account for the lack of effect in the Clements-Davis & Ley (1991) study, where high school students received no instruction on how to use the thematic pre-organizers that they were given to assist story reading. Alvermann and Boothby (1986) also failed to demonstrate an improvement in comprehension. In this case, the lack of improvement is quite likely due to a ceiling effect – as comprehension scores were quite high even before the intervention. Thus, weighing the collective evidence there still appears to be strong support for the ability of graphic organizers to improve reading comprehension.

The Effectiveness of Graphic Organizers for Improving Vocabulary Knowledge

Moore and Readence's (1984) meta-analysis suggests that gains in vocabulary knowledge following graphic organizer use may be even greater than gains in comprehension. The average effect size for the 23 studies reviewed was more than twice as large as that reported for comprehension. Thus, graphic organizers appear to be a very effective tool for improving vocabulary knowledge.

Factors Influencing Effectiveness

A wide variety of factors have been investigated for their influence on the effectiveness of graphic organizers for improving student learning. In this section, we review important findings that have emerged from this kind of analysis, starting with the issue of disability.

Disability

A fair number of studies have included students with disabilities in their investigations of graphic organizers. Successful learning outcomes have been demonstrated for both students with learning disabilities (Anderson-Inman, Knox-Quinn, & Horney, 1996; Boyle & Weishaar, 1997; Bulgren et al., 1988; Gallego et al., 1989; Gardill & Jitendra, 1999; Idol & Croll, 1987; Newby, Caldwell, & Recht, 1989; Sinatra et al., 1984) and students without disabilities (Alvermann & Boothby, 1986; Bulgren et al., 1988; Darch et al., 1986; Willerman & Harg, 1991). Table 1 provides a basic description of these findings.

– TABLE 1 –
Main research findings regarding the impact of graphic organizer use on students with disabilities.

Boyle & Weishaar (1997)	Students with learning disabilities	Students taught to generate cognitive organizers for use during reading and students who were taught to use expert-generated cognitive organizers during reading scored significantly higher than untaught peers on a comprehension test of literal

		and inferential comprehension.
Bulgren et al. (1988)	Students with learning disabilities and students without learning disabilities	When teachers used a concept teaching routine to present concept diagrams to students, students with and without learning disabilities significantly improved performance on tests of concept acquisition and improved their notetaking.
Gallego et al. (1989)	Students with learning disabilities	Learning and rehearsing a semantic mapping procedure was associated with a significant increase in quantity and quality of in class verbal contributions and a significant increase in the quality of their written summaries
Gardill & Jitendra (1999)	Students with learning disabilities, one student with neurological impairments, all experiencing difficulty with reading comprehension	direct instruction with an advanced story map procedure led to an improvement in students' basal comprehension scores and story grammar comprehension.
Idol & Croll (1987)	Special education students with reading comprehension problems	Training to use story-mapping procedures led to an improvement most students' ability to answer comprehension questions.
Sinatra et al. (1984)	Students referred to a reading clinic	Students who took part in instruction with a story mapping procedure answered significantly more comprehension questions correctly on average than students who took part in a directed reading approach.

Grade Level

Graphic organizers have been investigated with student populations across a range of grade levels, including elementary, junior high, and high school. On average the largest effects of graphic organizers on learning from text have been reported for University populations (Moore & Readence, 1984). However, there are consistent although more modest effects for elementary populations (Moore & Readence, 1984).

Point of Implementation

Graphic organizers may be introduced as advance organizers, before the learning task, or as post organizers, after encountering the learning material. A review of the research from 1980-1991 (Hudson, Lignugaris-Kraft, & Miller, 1993) concludes that visual displays can be successfully implemented at several phases of the instructional cycle. Indeed, positive outcomes have been reported when graphic organizers are used as both advance (Boyle & Weishaar, 1997; Gallego et al., 1989) and post organizers (Alvermann & Boothby, 1986; Boyle & Weishaar, 1997; Gardill & Jitendra, 1999; Idol & Croll, 1987; Newby et al., 1989; Sinatra et al., 1984; Willerman & Mac Harg, 1991).

However, the precise point of implementation does appear to influence the degree of graphic organizers' effectiveness. In their comprehensive review, Moore and Readence (1984) report that the point of implementation is a crucial factor in determining the magnitude of improvement in learning outcome. When graphic organizers were used as a pre-reading activity, average effect sizes were small. In contrast, graphic organizers used as a follow-up to reading yielded somewhat large improvements in learning outcomes. Thus, efforts to improve learning outcomes may be more successful when graphic organizers are introduced after the learning material.

Instructional Context

In reviewing 11 years of research, Hudson et al., (1993) note that positive outcomes for curricular enhancements require the use of effective teaching practices. Merkley & Jefferies (2001) note that, "It is important, however, that GO planning extend beyond construction of the visual to the deliberate consideration of the teacher's strategies…to accompany the visual." Thus, instructional context is another determinant of the effectiveness of graphic organizers for improving learning.

Without teacher instruction on how to use them, graphic organizers may not be effective learning tools (Carnes et al., 1987; Clements-Davis & Ley, 1991). Graphic organizers can successfully improve learning when there is a substantive instructional context such as explicit instruction incorporating teacher modeling (Boyle & Weishaar, 1997; Gardill & Jitendra, 1999; Idol & Croll, 1987; Willerman & Mac Harg, 1991) and independent practice with feedback (Boyle & Weishaar, 1997; Gardill & Jitendra, 1999; Idol & Croll, 1987), strategy instruction (Anderson-Inman et al., 1996; Boyle & Weishaar, 1997; Darch et al., 1986; Scanlon, Deshler, & Schumaker, 1996), story mapping (Gardill & Jitendra, 1999; Idol & Croll, 1987), semantic mapping (Gallego et al., 1989), and concept teaching routines (Bulgren et al., 1988). Most successful interventions minimally include a teacher introduction describing the purpose of the graphic organizer and setting the reading purpose.

In the absence of systematic study of the role of instructional context, it is difficult to identify with confidence specific aspects that are tied to success. However, in our review an interactive/collaborative approach involving teacher modeling, student-teacher discussion, and practice with feedback appeared to be consistently correlated with learning improvement (Alvermann & Boothby, 1986; Bulgren et al., 1988; Gardill & Jitendra, 1999; Idol & Croll, 1987; Scanlon et al., 1996). Thus, contexts that provide opportunity for student input and interaction with the teacher and/or one another (Darch et al., 1986; Gallego et al., 1989) may be especially effective.

Also useful are Merkley and Jefferies' (2001) specific suggestions for teaching with graphic organizers. Their guidelines include: verbalizing relationships between the concepts represented within the organizer, providing opportunities for student input, connecting new information

to past learning, making reference to upcoming text, and reinforcing decoding and structural analysis.

A relatively new area of research is the investigation of computer-based methods for presenting graphic organizer instruction. Herl et al. (1999) tested the effectiveness of two computer-based knowledge mapping systems in a population of middle and high school students. Students either worked individually using an artificial Web space to augment and revise knowledge maps or networked with one another across computers to collaboratively construct maps. Knowledge mapping scores (determined by comparison to expert maps) were significantly improved for individuals working individually to elaborate maps, but not for students involved in collaborative construction. These findings indicate that a computer-based system can be successfully used to instruct students on how to develop concept maps. They also suggest that Web searching methods may improve students' abilities to develop sophisticated maps. Student collaborative approaches, however, may be less effective.

Carnes et al. (1987) constructed computerized advanced organizers to help introduce high school physics students to microcomputer physics tutorials but were unable to establish a significant improvement in learning rate, retention, or performance on a teacher-made achievement test. However, the lack of effect is likely attributable to the absence of teacher introduction or training with the organizers.

Findings by Anderson-Inman et al. (1996) found substantial variability in the adoption of computer-based graphic organizer study strategies. Some students became quite skilled and independent with these strategies, while others developed only basic skills and remained reluctant in their use. Their finding that differences in adoption level were correlated with reading test and intelligence scores suggests that it may be possible to predict levels of user proficiency.

Successful learning outcomes can be obtained in a variety of classroom settings, including special education classrooms (Anderson-Inman et al., 1996; Boyle & Weishaar, 1999; Gardill & Jitendra, 1999) mainstream classrooms (Alvermann & Boothby, 1986; Bulgren et al., 1988; Darch et al., 1986; Willerman & Mac Harg, 1991) and one-on-one instruction (Idol & Croll, 1987; Newby et al., 1989; Sinatra et al., 1984). However, the relative ease of implementation is an important determinant of this success (Novak, 1980). Some instructional contexts that have been successful in research studies are unfortunately difficult for teachers and or students to implement. For example, Scanlon et al. (1996) developed (collaboratively with teachers) a 5-step strategy and substrategy for helping students in academically diverse classes to process information and put it into a graphic organizer for studying and/or writing. Teachers in the study implemented the prescribed teaching behaviors to much less of a degree than they had promised and expressed dissatisfaction with the lack of fit with their regular teaching routine. Students trained with the strategy performed better than controls on a strategy performance test, but to only a modest degree. They were at best ambivalent about the utility of the strategy for improving learning. Moore and Readence (1984) make similar observations in their meta-analysis, noting frequent reports that students were unable to appreciate the value of graphic organizers to learning and felt that these tools were out of place in the current instructional context. To draw more solid conclusions about the best ways to implement graphic organizers, more systematic investigations of the role of instructional context are needed.

Summary

Research studies show that graphic organizers are effective enhancements for students with and without learning disabilities. Successful learning outcomes are contingent on certain other factors (Figure 3.). Important considerations are grade level, point of implementation, instructional context, and ease of implementation. Thus, smartly implemented, graphic organizers have the potential to positively impact learning by offering teachers a means to improve all students' comprehension and vocabulary knowledge.

Important Factors Influencing the Effectiveness of Graphic Organizers

- **Grade level**: the largest effects have been reported for University populations; consistent but more modest effects have been reported for students in elementary grades.
- **Point of implementation**: graphic organizers generate larger improvements in learning when used as a follow up to reading rather than a pre-reading activity.
- **Instructional context**: graphic organizers can be effective learning tools when implemented within a substantive instructional context, particularly a interactive/collaborative approach involving teacher modeling, student-teacher discussion, and practice with feedback.
    - computer-based graphic organizer instruction can be successful if there is thorough teacher introduction and training on graphic organizer use.
    - graphic organizers can be successfully used in a variety of classroom settings including the mainstream classroom, special education classroom, and a one-on-one context.

Figure 3. At least four important factors influence the effectiveness of graphic organizers as a learning enhancement.

The next section of this report introduces the reader to the theory and research behind Universal Design for Learning (UDL). We then and investigate the links and connections between UDL and graphic organizers. Additionally, we identify methods and materials that may be implemented to support the implementation of graphic organizers in concert with the principles of UDL. Finally a set of guidelines for UDL implementation are provided including a listing of Web resources to provide further information on the concepts presented in this report.

An Introduction to Universal Design for Learning Applications

Universal Design for Learning is a theoretical framework developed by CAST to guide the development of curricula that are flexible and supportive of all students (Dolan & Hall, 2001; Meyer & Rose, 1998; Pisha & Coyne, 2001; Rose, 2001; Rose & Dolan, 2000; Rose & Meyer, 2000a, 2000b, 2002; Rose, Sethuraman, & Meo, 2000; TES Web site) The concept of UDL was inspired by the universal design movement in architecture. This movement calls for the design of structures that anticipate the needs of individuals with disabilities and accommodate these needs from the outset. Universally designed structures are indeed more usable by individuals with disabilities, but in addition they offer unforeseen benefits for *all* users. Curb cuts, for example, serve their intended use of facilitating the travel of those in wheelchairs, but they are also beneficial to people pushing strollers, young children, and even the average walker. And so, the process of designing for individuals with disabilities has led to improved usability for everyone.

Similarly, but uniquely, UDL calls for the design of curricula with the needs of all students in mind, so that methods, materials, and assessment are usable by all. Traditional curricula present a host of barriers that limit students' access to information and learning. Of these, printed text is particularly notorious. In a traditional curriculum a student without a well-developed ability to see, decode, attend to, or comprehend printed text is compelled to adapt to its ubiquity as best as he or she can. In contrast, a UDL curriculum is designed to be innately flexible, enriched with multiple media so that alternatives can be accessed whenever appropriate. A UDL curriculum takes on the burden of adaptation so that the student doesn't have to, minimizing barriers and maximizing access to both information and learning.

The UDL framework guides the development of adaptable curricula by means of 3 principles (Figure 4).

Principles of the Universal Design for Learning Framework
Principle 1: To support recognition learning, provide multiple, flexible methods of presentation
Principle 2: To support strategic learning, provide multiple, flexible methods of expression and apprenticeship.
Principle 3: To support affective learning, provide multiple, flexible options for engagement.

Figure 4. The three UDL principles call for flexibility in relation to three essential facets of learning, each one orchestrated by a distinct set of networks in the brain.

These 3 principles parallel 3 fundamentally important learning components and 3 distinct learning networks in the brain: recognition, strategy, and affect (Rose & Meyer, 2002). The common recommendation of these 3 principles is to select goals, methods, assessment and materials in a way that will minimize barriers and maximize flexibility. In this manner, the UDL framework structures the development of curricula that fully support every student's access, participation, and progress in all 3 essential facets of learning.

Critical to successfully implementing UDL theory is the use of digital materials. Digital materials, unlike the conventional pedagogical mainstays, speech, printed text, and printed images, have an inherent flexibility. They can be modified in a host of ways, depending on the needs of the student. This flexibility makes it feasible to customize learning materials and methods to each individual.

For teachers wondering *how* to customize the curriculum, CAST has devised three sets of broad teaching methods that support each of the 3 UDL principles (Figure 5., Rose and Meyer, 2002).

Network-Appropriate Teaching Methods
To support diverse recognition networks: • Provide multiple examples • Highlight critical features • Provide multiple media and formats • Support background context. **To support diverse strategic networks:** • Provide flexible models of skilled performance • Provide opportunities to practice with supports • Provide ongoing, relevant feedback • Offer flexible opportunities for demonstrating skill. **To support diverse** affective networks**:** • Offer choices of content and tools • Offer adjustable levels of challenge • Offer choices of rewards • Offer choices of learning context.

Figure 5. To help teachers support learners' diverse recognition, strategic, and affective networks CAST has developed three sets of UDL teaching methods. These teaching methods can be used to make the curriculum more flexible and broadly supportive.

These teaching methods draw on knowledge of the qualities of digital media and how recognition, strategic, and affective networks operate. For example, the first Teaching Method to support recognition learning is to *provide multiple examples*. This teaching method takes advantage of the fact that recognition networks can extract the defining features of a pattern and differentiate it from similar patterns simply by viewing multiple examples. Although presentation of multiple examples might be challenging in a classroom limited to printed text and hard copy images, digital materials enable the assembly, storage, and maintenance of a large collection of examples in the form of digital text, images, sound, or video – all in the modest space of a classroom. This is one example of how digital materials and UDL Teaching Methods can facilitate the successful implementation of UDL.

The UDL Teaching Methods will anchor the upcoming discussion where we will highlight the ways in which graphic organizers align with each of the 3 UDL principles. Within the context of these teaching methods we'll show how graphic organizers can support individualized instruction of recognition, strategic, and affective learning.

Graphic Organizers and the Three Universal Design for Learning Principles

Digital materials such as graphic organizers are an excellent resource for diversifying the curriculum in a UDL way, because they, themselves, are flexible. The following 3 sections

explore how graphic organizers can support individual differences in how students recognize cues and patterns, master skills, and engage with learning.

Recognition learning. The first UDL principle recommends that we support recognition learning by providing multiple, flexible methods of presentation. No single teaching method can make every student an expert at recognizing patterns. Graphic organizers can help ensure that every student succeeds by supporting four broad UDL Teaching Methods.

Students master patterns in part by viewing *multiple examples*, and graphic organizers, which come in many different forms, offer teachers a way to provide these examples. For example, a teacher could facilitate students' understanding of cause and effect by developing concept maps of different examples or by using different types of maps (Fishbone Map, Sequential Episodic Map, or Problem and Solution Map) to map the same cause and effect information. Because graphic organizers can be saved in a digital format, these multiple examples can be stored and accumulated for future use. Students can select the examples most effective for them. Teachers can also use graphic organizers as an alternative means to *highlight* the *critical features* of a pattern. Story grammar maps are an example.

Students vary in their ability to process *different media and formats*. Graphic organizers, which can incorporate not only text but also multimedia, provide an alternative to speech and linear text that may be preferable to some students. The geometric shapes used in some graphic organizers may help some students to better visualize patterns. Making graphic organizers available increases the odds that a student can find a format and medium that are accessible and useful to him or her. And within the broad class of graphic organizers there are a whole variety of formats to choose from. Even students for whom access is not a problem will benefit from the redundancy of mixed media and formats, which can foster deeper understanding of a pattern's essential characteristics.

Another way that graphic organizers can help to minimize barriers to recognition learning is by *supporting background knowledge*. What students learn is partly a matter of what they already know. Graphic organizers can help students to make connections between existing knowledge and new knowledge. They are a good complement to familiar ways of supporting background knowledge such as linear text. And because they are digital they can be built into reading and other material, enabling students the choice of accessing a whole variety of information when and as is best for them.

Strategic learning. The second UDL principle recommends that we support strategic learning by providing multiple, flexible methods of expression and apprenticeship. Students have different strengths and weaknesses in this area, too, making it important to vary the instruction of skills and strategies.

Students need *flexible models of skilled performance*, and graphic organizers are one way to succeed with this kind of diversification. Completed graphic organizers offer students an alternative to linear text-, audio-, live demonstration-, or image-based models that they may be unable to access. Access issues aside, adding graphic organizers to the usual mix of models helps to expose students to different, effective ways to do something. There are in fact many different types of graphic organizers, providing students with a broad selection of models even within the one category.

When it comes to practicing skills, graphic organizers can be used to ensure that students have the support that they need to make practice effective. *Supported practice* is made possible by customizable features such as links to Web resources, text-to-speech, provision of headings or partial filling in of a graphic organizer. These features help match the level of support to the individual student's needs.

Students also need *flexible opportunities for demonstrating skill,* and the use of graphic organizers helps to diversify options for students. They offer students alternatives to traditional ways of demonstrating skill such as written compositions. Students can put together text in a nonlinear format, organize a collection of images, or develop a multimedia display.

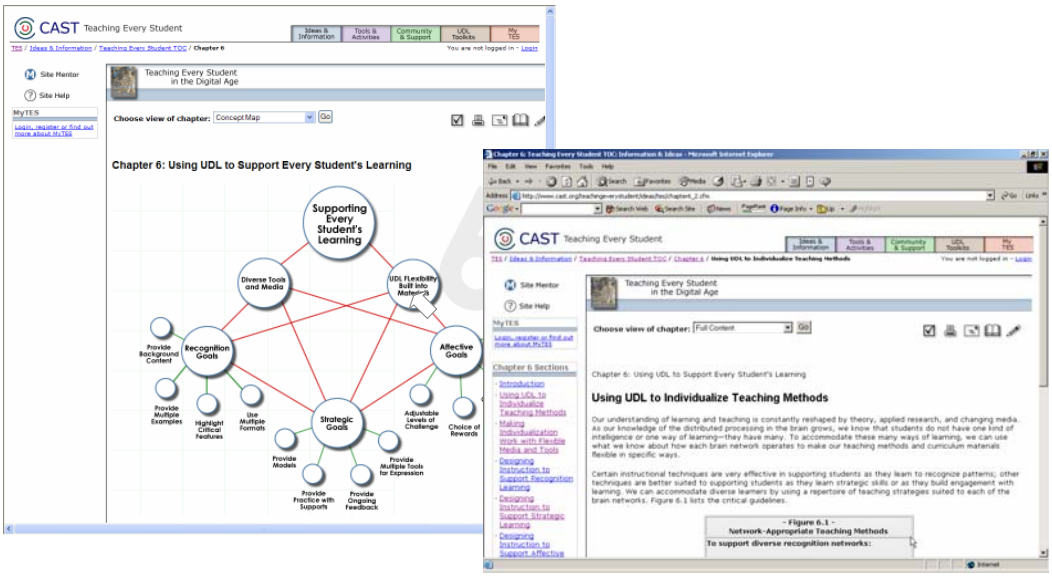
Affective learning. The 3rd UDL principle recommends that we support affective learning by providing multiple, flexible options for engagement. Students vary widely in their preferences and interest, and tools such as graphic organizers can help keep everyone engaged.

There are 3 key ways that graphic organizers support multiple, flexible options for engagement. First, they can be used to offer students a *choice of tools*. The freedom to select tools based on personal interests and strengths can help maintain a good level of interest and even re-engage learners. Moreover, when working with graphic organizers students can select from *different media* (text only, images, multimedia) *and formats*. Graphic organizers can also be used to provide *adjustable levels of challenge* during a task. Scaffolds can be flexibly accessed to ensure that each student is working at the appropriate level of difficulty. Similarly by varying the availability of scaffolds and other built-in forms of structure, students have access to *varied learning contexts*, increasing the chances that they will find one suitable to them – be it highly or minimally structured.

Examples

In the above section, we have highlighted the many ways that graphic organizers support the three UDL principles and align with UDL teaching practices. In this section, we go one step further, showing that this can work not only in theory but in practice as well. Here we present three examples of a UDL application of graphic organizers, two from CAST work, and one from outside work. For each of the CAST examples, we highlight the ways that graphic organizers are used to implement UDL teaching methods. For the outside example, we identify general UDL features in the existing lesson and then highlight ways that graphic organizers could be used to make the lesson even more UDL and reduce lingering barriers.

Teaching every student web site. The companion Web site to the book Teaching Every Student in the Digital Age offers a digital version of this text for adult learners of Universal Design for Learning. This online version offers four different views of each chapter, one being a graphic organizer view. When this view is selected, a graphic organizer overview of the text appears on the screen. Users can then navigate the chapter by clicking on the "bubbles" that represent the different chapter sections. Users who select this view can navigate the chapter by clicking on graphic organizers to navigate the full text.



In addition to this interactive graphic organizer feature, both the printed and digital version of the text offer a noninteractive graphic organizer overview at the beginning of each chapter (an exception is the Full Content version). The Web site's innovative use of graphic organizers supports a variety of UDL teaching methods, which we have summarized below in Table 2.

–TABLE 2 –

UDL Applications of Graphic Organizers on TES

UDL Teaching Method	Supportive Graphic Organizer Feature(s)
Provide multiple examples.	Collectively, the Graphic Organizer view and the Summary view (which at the beginning of the chapter lists key ideas) provide multiple examples of the major topics in each chapter.
Highlight critical features.	The graphic organizer overview of each chapter helps readers to zero in on critical features of the text. The text formatting and graphics identify major and minor section headings and highlight the relationships between the different sections' topics.
Provide multiple media and formats.	Readers have a choice of viewing and navigating the text through a conventional view or a graphic organizer view. Either can be read using text-to-speech.
Support background context.	The graphic organizers provide important background knowledge by establishing the relationships between the various topics to be discussed in the chapter. Viewing the graphic organizer may also help readers to connect to their existing knowledge on the topics.

Provide opportunities to practice with supports.	The graphic organizer overview helps to support readers' comprehension of the text by identifying key ideas (communicated via the headings) and helping to demonstrate their interrelationships.
Offer choices of content and tools.	The graphic organizer view is one of several viewing options that online visitors have for reading the text. And the graphic organizer view enables users to navigate the chapter as they choose – they are not bound to linear navigation of the text.
Offer choices of learning context.	The graphic organizer view provides readers with alternatives to the traditional, linear reading context.

CAST Monkey's Paw unit from Planning for All Learners (PAL) toolkit. The PAL Toolkit's Monkey's Paw unit is a series of 10 lessons involving the story "Monkey's Paw" by W. W. Jacobs. The unit supports ninth and tenth grade English/Language Arts courses in which students read and analyze short stories, novels, and classic literature. We focus on Lessons 2 and 4, which have the common goals of building student engagement in story reading and comprehension and developing vocabulary and the ability to analyze plot elements. Graphic organizers, in the form of plot diagrams and semantic maps, are used in several ways.

During the vocabulary development portion of Lesson 2, the teacher uses a graphic organizer in *PowerPoint* to organize a discussion of examples and non-examples consistent with various word definitions. Later, students work with a printed or digital version of the story's plot diagram as they read Part 1 of the story and try to define what a story exposition means. During Lesson 4, graphic organizers are used again as the teacher reviews the exposition plot diagrams from the previous lesson and students continue to work on their plot diagrams, using them to depict other plot elements. These lessons are good examples of how graphic organizers can be used to support UDL and accommodate diverse learners. In Table 3, we detail specific ways that these lessons use graphic organizers to put UDL teaching methods into practice.

–TABLE 3 –

UDL Features of PAL Toolkit Lessons

UDL Teaching Method	Supportive Graphic Organizer Feature(s)
Provide multiple examples.	During the vocabulary activity, the graphic organizer is used to present multiple examples and non-examples to the students.
Highlight critical features.	Using the graphic organizer to contrast examples and non-examples of words consistent with a definition is a way to highlight critical features of vocabulary. In addition, the plot diagrams help to highlight key plot elements through both text and graphics.

Provide multiple media and formats.	Students have the option of working with graphic organizers in different media and formats: large presentation/display version, printed version, digital version with text and/or images. With the digital version of the graphic organizers, text-to-speech can be used.
Support background context.	The vocabulary instruction provides background knowledge so that students can comprehend the reading. In addition, students can review plot diagrams created in Lesson 2 to provide background for their work around plot elements in Lesson 4.
Provide flexible models of skilled performance.	The teacher provides multiple methods for instruction and use of the story plot diagram: large presentation/display, paper pencil for individual students, and digital version.
Provide opportunities to practice with supports.	With the digital version of the graphic organizers, text to speech can be used as well as a spell checker. The format of the text can be altered to suit a student's visual needs. And, the type entry mode supports students who have trouble hand writing.
Provide ongoing, relevant feedback.	Students can use text-to-speech to play back their entries into the digital graphic organizers, providing them with a way to self-monitor.
Offer flexible opportunities for demonstrating skill.	Students have a choice of how to complete their plot diagrams. They can print their responses on a hardcopy graphic organizer or type them into a digital version.
Offer choices of content and tools.	Students have a choice of using a digital or hardcopy graphic organizer. And they can input text and/or images into the plot diagrams.
Offer adjustable levels of challenge.	Students have the opportunity to collaborate with others to complete the plot diagram. And the digital version offers supports.
Offer choices of learning context.	Students can complete the plot diagram in varying contexts: • large group • cooperative study groups, and • individual students.

As the Tide Turns: Radio Broadcasts from the Front, a sample lesson plan from SAS in School's Curriculum Pathways.[TM] One of the main objectives of this lesson plan, which is

focused on building an understanding of crucial World War II battles, is to use a graphic organizer to plot the course of an important military turning point in the war.

This lesson is consistent in a number of ways with UDL principles and teaching methods (see Table 4). Through clearly stated goals and the use of digital materials such as the Internet, audio files, and graphic organizers; a good amount of flexibility has been injected into the lesson, helping to minimize barriers. There are yet additional ways to minimize barriers in this lesson using UDL teaching methods and graphic organizers. In Table 5, we give some examples of how the UDL features of graphic organizers can be used to further improve this lesson's ability to reach all students. Note that we are not making generalized recommendations for making this lesson more UDL but instead are focusing on ways that graphic organizers, specifically, can help achieve this goal.

–TABLE 4 –

Existing UDL Elements in "As the Tide Turns: Radio Broadcasts from the Front" Lesson Plan

UDL Teaching Method	Supportive Lesson Feature(s)
Provide multiple examples.	The teacher provides multiple web resources for each battle.
Provide multiple media and formats.	The teacher provides suggested web resources that offer text, images, and audio.
Provide opportunities to practice with supports.	The teacher scaffolds the research process by providing suggested web resources.
Offer flexible opportunities for demonstrating skill.	Students have the opportunity to create a graphic organizer, write a news broadcast, or produce and record a news broadcast.
Offer choices of content and tools.	Students can choose what graphic organizer to use. Some students are permitted to choose a task to complete, and along with it the tools. The lesson plan leaves open the possibility of working with a digital or hard copy version of the graphic organizer.

–TABLE 5 –

UDL Strategies for Using Graphic Organizers to Further Minimize Lesson Barriers in "As the Tide Turns: Radio Broadcasts from the Front"

Barrier	UDL Strategy
Choosing the appropriate graphic organizer for the task.	Provide background information on graphic organizers and their use (in printed and digital format).
Writing the headings and brief explanations that go in the graphic organizer.	Offer use of speech recognition, spell checker, and grammar checker when using graphic organizers; link from graphic organizer program to supports such as a thesaurus.
Organizing the headings and brief explanations to connect the different pieces of researched information.	Offer students the option of inserting images or sound clips to help organize thoughts and information before beginning to write the text. Provide links to background information that may help with the task of connecting pieces of researched information. Provide models of completed graphic organizers. Provide templates customized to the student: some will be partially filled in, some will provide tips on connecting information.
Task is too easy for some students	Provide students who need more challenge with a list of more complex graphic organizers.
Task is boring for some students	Offer students the option of incorporating images, audio, and video into the graphic organizer; show students how to customize the graphic organizer by using different colors and text styles.

Recommendations for Implementation at the Classroom Level

Although UDL applications of virtual reality and computer simulations already exist, they are admittedly hard to come by. Even with such models available, teachers face challenges in implementing them: the challenges of shifting away from traditional views of intelligence and traditional reliance on print media, the challenge of acquiring and mastering new technology, and the challenge of garnering support from the school system. The following sections offer recommendations that can help teachers overcome each one of these challenges.

Learn about universal design for learning. The first and most basic step toward successfully implementing UDL is self-education. Although UDL has been more than a decade in the making, it is a new approach and one that challenges many traditional educational perspectives and practices. Before teachers can implement UDL effectively, they may need to learn a different way of looking at their students and the materials that they use in the classroom. CAST has been working to disseminate UDL widely, and, consistent with the framework itself, have developed multiple avenues (direct and indirect, self-driven and trainer-taught, through text, speech, and

interactive activities) through which individuals can learn about UDL and develop the skills necessary to put it into practice.

- Visit the CAST Web site. The CAST Web site devotes a large section to Universal Design for Learning. Here visitors will find an articulation of UDL, discussions of its core concepts, descriptions of UDL research projects, a listing of tools and resources that support UDL, and ideas and examples for implementing UDL.

- Read CAST publications. CAST has a range of publications highlighting UDL and UDL practice, including *Teaching Every Student in the Digital Age* (Rose & Meyer, 2002). The companion Web site to the book provides an evolving set of resources and classroom examples, including interactive activities and an online community where visitors can ask questions and engage in discussion about UDL.

- Enroll in an institute. Professional development institutes by CAST teach professionals about the challenges of improving access to and progress and participation in the general education curriculum and how to make the curriculum accessible for all learners.

- Talk to others. The Teaching Every Student section of the CAST Web site includes an online community where teachers can communicate, collaborate and obtain support from other educators who are exploring and teaching with UDL.

- Find more information and engage in discussion about universal design and increasing access for students with disabilities at the Web site for the Access Center, a national technical assistance center that is funded by the U.S. Department of Education's Office of Special Education Programs make elementary and middle school curricula more accessible to students with disabilities.

Inventory and build technology support. Technology, in particular digital media, makes UDL implementation practical and achievable in a diverse classroom. Digital materials make it possible for the same material to be flexibly presented and accessed – even adapted on a student-to-student basis.

Although we recommend that teachers try to build a library of digital materials, it is important to point out that UDL implementation can proceed successfully across a range of technology availability. The amount of technology available to teachers varies extensively - limited by district and school resources, both monetary and otherwise. Fortunately, a fairly simple step such as digitizing print materials can greatly ease UDL implementation. The 1996 United States copyright additions (Chapter 1 of Title 17 Section 121 of the United States Code), the Chafee Amendment, gives authorized entities the freedom to digitize otherwise proprietary materials for individuals that have disabilities that impede access to the printed version. An authorized entity is a nonprofit organization or governmental agency that has a primary mission to provide specialized services relating to training, education, or adaptive reading or information access needs of blind or other persons with disabilities. This provision makes special education teachers eligible to digitize printed text materials, a step that can help to diversify the presentation of materials for students with disabilities.

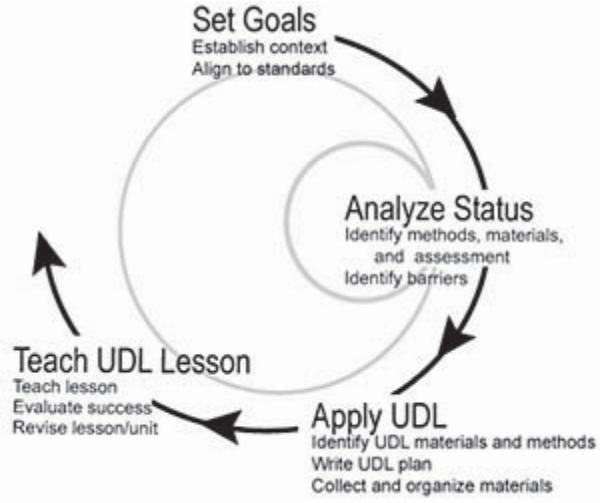
Another inexpensive but instrumental option for supplying a classroom with digital materials is the World Wide Web – a tremendous source of free digital material. And much of this material is in a multimedia format, which can greatly improve access to students.

Having more digital media unquestionably enables teachers to implement UDL in a more extensive way. Teachers who have greater financial resources and district support can supplement their materials with innovative products such as multimedia composition tools (e.g. HyperStudio, Kid Pix, PowerPoint), graphic organizer software (e.g. Inspiration, Kidspiration), text-to-speech and text-to-image programs (e.g. CAST eReader, Pix Reader, Pix Writer, Intellitalk II), CD-ROM storybooks (e.g. Reader Rabbit's Reading Development Library), and learning software (e.g. 7th Level's Great Math Adventure, Edmark's various learning games).

Whether teachers are able to invest in the purchase of a lot of technology or not, UDL can proceed effectively. But taking inventory is an important step toward setting a realistic course of action. By inventorying the resources they have available to them, teachers can determine the level of UDL implementation appropriate to their classroom. For example, visit the school media center and get an idea of computer and projection systems available to teachers and students. Find out if these tools are portable or fixed; this implies where instruction may take place. Check into scheduling issues around shared equipment. Additionally, check out Web accessibility in classrooms, school computer labs and media centers. If the Web is a tool you may use and ask students to access, how available is it? Additionally, take an inventory of your school or district software; find out what's available and if the purchase permits installation on computers you will be using.

Effectively working with and managing technology can be a challenging process, so it is important as well to inventory the available technology support. This may come in the form of a technology specialist (computer teacher, computer resource specialist, technology integration teacher) or one's own technology training. Find out what policies your school or district may have regarding the tools you may adopt for use in your planning and teaching. Installation of software and hardware on computers may be time consuming; plan for issues of timing in your implementation. When you are ready to teach a lesson using some technologies new to you or your students, consider notifying your technology support person to be at hand to help problem solve any unforeseen challenges with implementation.

Curriculum planning and delivery. Another important step in implementation of UDL in instruction is curriculum planning and delivery. To begin with we recommend that teachers have a basic understanding of UDL and a commitment to make the curriculum and learning accessible for all learners. While keeping in mind the three principles of UDL, based on the recognition, strategic and affective networks, we have found the following process useful in designing lessons. The process includes four steps, based upon the principles and concepts of UDL, proven professional development strategies, and effective teaching practices; (a) Set Goals, (b) Analyze Status, (c) Apply UDL, and (d) Teach the UDL Lesson.



In the *Set Goals* stage of curriculum planning, we recommend that teachers establish the context for instruction. Context is usually driven or based on state standards, followed by the design of goals for the instructional episode. We recommend that all teachers closely evaluate these to ensure alignment and that the means for attaining the goals are separated from the goals and standards.

Next, when designing a UDL lesson, teachers should Analyze the Current Status of the instructional episode. What are the current methodologies, assessments, and materials used to teach the lesson? Analyze these teaching procedures in relation to potential barriers of learners in the classroom. Do all students have access to the materials? Are students able to express themselves with the current methods and materials? There are a number of resources and tools available from CAST to analyze lessons in the *Planning for All Learners Toolkit* located on the TES Web site.

The third recommended step of the planning process is to *Apply UDL to the Lesson/Unit*. This includes the goals, methods, assessments and materials used to implement the lesson. Create the UDL lesson plan, grounded in the learning goals, classroom profile, methods and assessment, and materials and tools. Then, collect and organize materials that support the UDL lesson.

In the final step, *Teach the UDL Lesson/Unit*, minimize barriers and realize the strengths and challenges each student brings to learning, rely on effective teaching practices, and apply challenges appropriate for each learner. In this way, instructors can engage more students and help all students progress. When teaching and evaluating students' work, also evaluate and revise the lesson/unit to assure student access and success. You may obtain additional information about designing UDL methods, assessments, and materials in Teaching Every Student in the Digital Age, Chapter 4.

Secure administrative support. School districts and administrations can be powerful sources of support – financial and otherwise. Administrative commitment to UDL can strengthen a teacher's sense of mission and self-satisfaction and lead to important funding. A case in point is the town of Gloucester, Massachusetts. The principal for the school system is so convinced of the importance of digitized materials that he has set a mandate that teachers use only those textbooks that have a digitized version. Teachers will use a text-to-speech reader to further improve the accessibility of the text. Clearly, this kind of change would have happened much more slowly in the absence of such tremendous administrator-level support.

Administrator support can also help to facilitate funding, which although not a prerequisite for UDL, can create important opportunities. Funding might enable the purchase of equipment, professional development, and the launching of new UDL teaching projects. Districts vary widely concerning the types and level of funding that they offer teachers, but teachers who can convince their administrators of the value of UDL may be able to secure district-level grants, professional development awards, and sabbaticals. For example, in a North Shore Massachusetts school district, the Technology Program Manager and Special Education Director teamed with two teachers using UDL, wrote and were recently awarded a state-level technology grant to implement UDL. This is just one example of how support at the administrative level can facilitate the acquisition of materials that support UDL efforts in the classroom.

Parent education and involvement. Parents are another valuable resource for teachers building a UDL curriculum. There are at least two important ways that parents can be a resource: as advocates and as volunteers.

By educating parents about the UDL activities going on in the classroom, teachers can develop a support system of informed individuals who can assist with and advocate for UDL instruction. Teachers should think about ways to inform parents about classroom activities. Notes sent home, parent night presentations, and IEP meetings are all excellent opportunities to engage in this kind of communication.

Once parents are educated about UDL they may wish to become involved themselves. There are many ways that parents can do this, including volunteering in the classroom and lending support at home. A few possibilities are scanning materials, monitoring kids during UDL lessons, helping with technology, donating equipment, and supporting homework assignments.

Conclusion

As more and more teachers begin to explore UDL in their classrooms, they will begin to augment books and lectures with new technologies. Graphic organizer software is undoubtedly a technology that can help teachers succeed at implementing UDL and developing curricula that make information and learning more accessible. Although these teachers will undoubtedly encounter challenges, models and resources continue to build – and along with them builds the opportunity to realize the potential of graphic organizers and UDL in the classroom.

Links to Learn More About Graphic Organizers

The Graphic Organizer Home Page
http://www.graphic.org/index.html

This site is a rich resource for learning about graphic organizers, offering links, lists of references and books about graphic organizers, information about using graphic organizers for writing, guidelines for designing graphic organizers and assisting students in designing them, and samples of student work with graphic organizers.

ReadingQuest.org
http://curry.edschool.virginia.edu/go/readquest/strat/

ReadingQuest offers information on a variety of graphic organizers, concept maps, diagrams, and charts. For each item there is a definition, description of how it works, and examples.

WriteDesign On-line
http://www.writedesignonline.com/organizers/index.html

The graphic organizers Web pages from WriteDesign On-line list 20 different graphic organizers and describe their use in the context of 8 activities: analyzing, brainstorming, comparing and contrasting, evaluating, hypothesizing, interacting, sequencing, and visualizing. The descriptions include visual examples.

Mrs. Dobbs

http://home.earthlink.net/~tsdobbs/home.html

This Web site, constructed by a 7th and 9th grade teacher, showcases more than 30 of her students' fantastic graphic organizer creations. The graphic organizers, which are grouped into 8 major types, colorfully illustrate not only the range of effective learning contexts for using graphic organizers but also the ways in which graphic organizers support student creativity.

The Access Center

http://www.k8accesscenter.org/

This Web site belongs to the Access Center, a national technical assistance center that is funded by the U.S. Department of Education's Office of Special Education Programs make elementary and middle school curricula more accessible to students with disabilities. The Web site hosts chats and discussions and offers publications and presentations on topics related to accessing the general education curriculum, including Universal Design for Learning.

EdTech Online

http://edservices.aea7.k12.ia.us/edtech/classroom/visual/graphorg.html

The graphic organizers section of EdTech Online offers a variety of practical resources for teachers. These include a description of 3 basic ways to create graphic organizers, ideas and examples from teachers for using graphic organizers in specific learning contexts (including lesson plans), and links to other Web sites.

Teach-nology

http://teachers.teach-nology.com/web_tools/graphic_org/

This Web site offers 7 graphic organizer generators, tools that enable you to make customized graphic organizers. Users fill out a simple online form and are instantly provided with an individualized graphic organizer that can be printed and/or saved for later use.

4 Blocks

http://www.k111.k12.il.us/lafayette/fourblocks/graphic_organizers.htm

This Web site about the 4 Blocks literacy framework provides overviews and links to examples and directions for some common graphic organizers.

ERIC Clearinghouse on Disabilities and Gifted Education

http://eric.hoagiesgifted.org/
This minibibliography prepared by the ERIC Clearinghouse on Disabilities and Gifted Education contains annotated readings about graphic organizers. The listings include journal articles, books, and Web sites.

ERIC Clearinghouse on Reading, English, and Communication
http://eric.indiana.edu/ieo/bibs/graphele.html

This ERIC bibliography provides an introduction to graphic organizers for Elementary instruction. The listed materials include Web sites, ERIC Database citations, and other books and lesson plans.

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