Graphic Organizers and Implications for Universal Design for Learning

Curriculum Enhancement Report

By Nicole Strangman, Ge Vue, Tracey Hall, and Anne Meyer

Published: 2004 (Links updated 2014)

This document was originally a product of the National Center on Accessing the General Curriculum (NCAC).

This version updated and distributed by the AEM Center.

The content of this document was developed under a cooperative agreement with the U.S. Department of Education, #H327Z140001. However, this content does not necessarily represent the policy of the U.S. Department of Education and you should not assume endorsement by the Federal Government. Project Officer: Michael Slade, Ed.D.

This work is licensed under a [Creative Commons Attribution-ShareAlike 4.0 International license.](http://creativecommons.org/licenses/by-sa/4.0/)



Strangman, N., Vue, G., Hall, T., & Meyer A. (2004). *Graphic Organizers and Implications for Universal Design for Learning: Curriculum Enhancement Report.* Wakefield, MA: National Center on Accessing the General Curriculum. (Links updated 2014). Retrieved [insert date] from http://aem.cast.org/about/publications/2003/ncac-graphic-organizers-udl.html

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

## 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, including digital versions of 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.

## 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. 

## Types of Graphic Organizers

Graphic organizers come in many different forms, each one best suited to organizing a particular type of information. The emergence of digital graphic organizers enable users to alternate between a text outline and graphic organizer view of the same information. The following examples are merely a sampling of the different types and uses of graphic organizers.

A **Descriptive or Thematic Map**, as shown above,works well for mapping generic information, and 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.**

 

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.

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**.



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



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; Canas, 2003; Novak, 2006; Ciullo 2013). Operations such as mapping cause and effect, note taking, comparing and contrasting concepts, organizing problems and solutions, relating information to main ideas or themes, and alternating between text outline and a graphic organizer view of the same information 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 (see list below). 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 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 contexts 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?

There is solid evidence for the effectiveness of graphic organizers in facilitating learning. Eleven of the thirteen 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 13 studies, 10 reported that graphic organizer use elevated comprehension. These studies included a variety of comprehension measures (see list below). The reliability of these improvements in comprehension is further supported by numerous meta-analyses (Moore & Readence, 1984; Dexter & Hughes, 2011; Dexter, Park, & Hughes, 2011; Ciullo, 2013). As a whole, these meta-analyses 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 (Bulgre,n et al., 1988; Willerman & Mac Harg, 1991)
* Written summaries (Gallego, Duran, & Scanlon, 1989)
* Story grammar tests (Gardill & Jitendra, 1999)
* Reading comprehension and writing skills (Hector, 2013)

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, and 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 advance organizers. This same factor may account for the lack of effect in the Clements-Davis and 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. Similarly, Dexter and Hughes (2011) and Dexter, et al.’s (2011) meta-analyses of graphic organizers found a moderate to high effect size for measures of vocabulary. 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 (LD) (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.

| Study | Participants | Focus & Impact |
| --- | --- | --- |
| Boyle & Weishaar (1997) | Students with learning disabilities | Students who were 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 their performance on tests of concept acquisition and improved their note-taking skills. |
| 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 student-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 in 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. |

Meta-analysis that focused on the use of graphic organizers with LD students also showed a positive effect on learning outcomes. Dexter and Hughes’ (2011) meta-analysis of the use of graphic organizers with LD students showed they had positive gains on vocabulary and comprehension measures.

### Grade Level

Graphic organizers have been investigated with student populations across a range of grade levels, including elementary, junior high, and high school. There are consistent although more modest effects for elementary populations (Moore & Readence, 1984; Dexter & Hughes, 2011; Dexter, et al., 2011; Ciullo, 2013).

Typically, in post-secondary educational settings, students are expect to acquire a large volume of academic knowledge and skills in a relatively short period of time through reading texts and from listening to lectures. Additionally, high-stakes mid-terms and final exams are the primary means for students to demonstrate their knowledge and skills. Students’ experience, and expertise with, using graphic organizers to facilitate reading and listening comprehension and to study for exams can be crucial to their success. On average, the largest effects of graphic organizers on learning from text have been reported for university 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 (Alvermann & Boothby, 1986; Boyle & Weishaar, 1997; Gardill & Jitendra, 1999; Idol & Croll, 1987; Newby, et al., 1989; Sinatra, et al., 1984; Willerman & Mac Harg, 1991) organizers.

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 outcomes. 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 and 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 include, at a minimum, a teacher-led 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 an 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 digital technology-based methods for presenting graphic organizer instruction. Digital-based graphic organizers can facilitate meaningful learning by enabling students to create and edit visual representations of information and alternate between different views of the same information (Novak, 2006). The flexibility and productivity affordance of digital graphic organizers also serves as an evaluation tool. Students graphical representations of content can be evaluated to identify understandings, misconceptions, and competencies (Novak, 2006). Ciullo’s (2013) meta-analysis of digital-based graphic organizers with LD students showed high effect sizes in social studies measures and moderate effects in written expression and reading comprehension measures.

Similarly, 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 digital-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 advance 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 of 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; Canas, 2003; Novak, 2006). 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 sub-strategy 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 only to 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 (see list below). 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’ reading comprehension, vocabulary knowledge, and learning across academic subjects.

### 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 and evaluation tools when implemented within a substantive instructional context, particularly an 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 of 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 in a one-on-one context.

The next section of this report introduces the reader to the theory and research behind Universal Design for Learning (UDL). We then investigate the links and connections between UDL and graphic organizers. Additionally, we identify methods and materials that may be used 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 (UDL) is a theoretical framework developed by CAST to guide the design and development of learning environments that represent materials in flexible ways and offer a variety of options for learners to comprehend information, demonstrate their knowledge and skills, and become motivated to learn (Meyer, Rose, & Gordon, 2014; Hall, Meyer, & Rose, 2012; CAST, 2011; Rose, Meyer, & Hitchcock, 2006; Pisha & Coyne, 2001; Rose, 2001; Rose & Dolan, 2000; Rose & Meyer, 2000a, 2000b, 2002; Rose, Sethuraman, & Meo, 2000). 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.

The universal design movement changed how architects think about designing buildings. Similarly, UDL calls for a shift in how educators think about designing learning environments. Traditional curricula in printed text and new curricula that incorporate inaccessible digital technology present a host of barriers that limit learners’ access to information, ability to express knowledge, and opportunity to be engaged in learning. With printed text, learners without an ability to see, decode, attend to, or comprehend printed text are compelled to adapt to its ubiquity as best they can. Similarly, if a new curriculum in a digital medium is not fully accessible from the start, not all learners will be able to navigate, interact, comprehend, and express their knowledge regarding it.

What is even more detrimental to learning is that fixed, one-size-fits-all curricula are designed and developed to address the needs of mainstream learners and, consequently, disregard the diversity in skills, needs, and interest that individuals bring to learning. In contrast, a UDL curriculum is designed and developed to take full advantage of the inherent variability in individual learners. As a result, a UDL curriculum is innately flexible, enriched with multiple media so that many paths are provided to develop the talents of all learners. In doing so, a UDL curriculum reduces barriers as well as optimizes the level of challenges and supports to meet the needs of learners from the start.

The UDL framework is based on neuroscience research evidence that individual learners differ in how they comprehend information (recognition network), how they express what they know (strategic network), and the ways in which they are motivated (affective network). Whether the differences facilitate learning or become a detriment to learning depends largely on the educational context. If a learning environment is flexible and can be adjusted to match an individual’s strengths, then a characteristic that is a deficit in one learning context becomes an asset in another. The characteristics of a learner and a curriculum are not fixed entities but continuously evolve together as the learner grows and progresses. As Meyer, Rose, and Gordon explain, “Success occurs when the learner and the curriculum interact in ways that help them both improve at the same time (2014).”

To guide educators in creating lessons, curricula, and learning systems that are engaging, maximize flexibility, and optimize learning, the three primary brain networks are translated into three UDL principles of design: 1) provide multiple means of engagement, 2) provide multiple means of representation, and 3) provide multiple means of action and expression (see Figure 1) (Rose, Meyer, & Gordon, 2014).

Figure 1. The three UDL principles call for flexibility in relation to three essential facets of learning, each one orchestrated by a primary brain network.



Each UDL principle is then expanded into UDL guidelines and checkpoints. The depth and comprehensiveness of the UDL guidelines can guide educators to build flexibility into all components of a curriculum—goals, methods, materials, and assessment—so that all students are supported in their access, participation, engagement, and ongoing monitoring of progress across all facets of learning.

Although the three primary brain networks that facilitate learning are described separately, they are in fact highly interconnected and continuously work in concert. Similarly, the components of a curriculum—goals, assessment, methods, and materials—are most effective when they are aligned. The flexibility that is at the core of a UDL curriculum is the result of crafting goal statements that avoid prescribing a particular way to achieve them. Learning goals that separate the means from the end provide educators the flexibility to include a variety of teaching methods and materials that can be adjusted to match student needs and strengths. For example, if the learning goal is for students to understand specific content then multiple options can be built into the curriculum for students to interact with the content (recognition network), for them to demonstrate their understanding of the content (strategic network), and enable them to engage and sustain their motivation in learning (affective network). Additionally, making appropriate adjustments during the course of instruction requires assessments that are ongoing, measure student progress, and capture student interactions with the curriculum. In a UDL curriculum, formative assessment, which is employed during instruction to monitor student progress and inform instructional decisions, is more valuable than summative assessments that measure student performance after the completion of instruction. Likewise, digital curricula that, for example, has the capacity to log every student action and then generate visual reports of students’ path through a curriculum over time, is more valuable than traditional curricula that do not capture student interaction. *Designing curriculum that adheres to the UDL principles ensures that the goals, methods, materials, and assessments work seamlessly together to optimize learning.*

One of the most essential ingredients of an effective curriculum is engaging students in learning. In a UDL curriculum, involving students in the process of setting a learning goal is as critical to its achievement as the goal statement itself. Having student re-state goals in their own words, asking students for feedback about goals, and supporting students to set goals for themselves are all critical to developing their self-efficacy and engagement in learning. Providing a rich array of materials and multiple paths to reach a goal not only recruits student interests and motivates them to learn but also provides opportunities for them to explore and develop their own interests. It is invaluable for educators to have immediate access to assessment information that they can use to inform instructional decisions as they are teaching. Similarly, involving students in monitoring their own progress by sharing information about their own learning behaviors and performances is empowering. When students view their own information, they ask and find answers to questions about themselves. What I am I doing? What is working? What can I improve? Thus assessment that is often a source of anxiety and stress becomes an opportunity to practice self-regulation skills and develop self-efficacy, key factors of motivation in learning.

Figure 2. Three primary principles guide UDL—and provide structure for the Guidelines.



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 a curriculum more flexible and broadly supportive.

### Graphic Organizers and the Three Universal Design for Learning Principles

As a tool for teaching and learning, graphic organizers have unique affordances for optimizing the learning of all individuals. The following section looks at the foundational principles of universal design for learning—engagement, action and expression, and representation—how the needs of learners vary across the 3 UDL principles, and the ways in which graphic organizers can support diverse learners to complete different learning tasks.

#### Recognition networks

The UDL principle that focuses on the principle of recognition and focuses on offering multiple, flexible ways of presenting information when teaching indicates that no single representation of information will be effective for every learner. This UDL principle is further articulated into guidelines to help educators use graphic organizers to facilitate learning.

Graphic organizers come in many different forms and can offer teachers many ways to provide multiple representations of the same information. 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 information about cause and effect. 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 perceive and comprehend information in *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 as they can foster deeper understanding of a pattern’s essential characteristics.

Another way that graphic organizers can help to minimize barriers to recognition network-related learning is by *activating 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 Networks

The UDL principle related to the strategic network focuses on providing multiple means of action and expression and recommends that educators offer multiple, flexible options for physical action, expression, and communication and executive functions. Students have different strengths and weaknesses in these areas. Graphic organizers can be used to instruct and to support students to act skillfully and develop into strategic learners.

Completed graphic organizers can support the UDL guideline *provide options for physical action* by scaffolding students’ interaction with information. For example, a completed digital diagram of an ecosystem can serve as an alternative to a physical model, an audio explanation, or a text description. Students can also traverse through and manipulate the digital diagram to explore and learn about an ecosystem.

Graphic organizers can support the UDL guideline *provide options for expression and communication* simply by being made available to students as an option for demonstrating their knowledge and skills. Instead of a traditional written composition, students can use graphic organizers to create visual representations that show their knowledge of a topic. Different types of graphic organizers offer students the flexibility of putting together text in a nonlinear format, organizing a collection of images, or developing a multimedia display. On the other hand, if the goal is to develop knowledge and skills in writing, placing writing steps and elements of structure of an essay into graphic organizers can scaffold and support students in starting a first draft. Students’ writing performance can be further supported by providing partially completed graphic organizers or links to additional resources about writing elements and models.

Graphic organizers can also be a tool for *planning and managing information and resources*. For example, while conducting research on a topic, students might use graphic organizers to gather and organize evidence. They might alternate between a graphical display and a text outline of their work to help them generate ideas and make a plan before drafting. Different types of graphic organizers and their unique features can be varied to provide supports that match individual student needs and specific writing tasks.

#### Affective Networks

The UDL principle related to the affective network forcuses on providing multiple means of engagement and recommends that educators provide options for recruiting interest, sustaining effort and persistence, and self-regulation. Students vary widely in what motivates and sustains their engagement in completing different learning tasks across different contexts. As a tool for learning and creating, graphic organizers have inherent flexibilities that make them suitable for engaging all learners.

Students differ in their preferences and interests and graphic organizers can be used to offer students a *choice of tools* to complete learning tasks. 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, images, multimedia) *and formats*.

Graphic organizers can also be used to *vary demands and resources to optimize challenges* during a learning task. Scaffolds can be flexibly accessed to ensure that each student is working at an 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 practices. In this section, we go one step further, showing that graphic organizers work not only in theory but in practice as well. We highlight the ways that graphic organizers are used to implement UDL practices. For the this 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 accessible and reduce lingering barriers.

[As the Tide Turns: Radio Broadcasts from the Front](http://www.sasinschool.com/resource/pages/lesson_plan_ww2.shtml), a sample lesson plan from SAS inSchool’s Curriculum Pathways.TM One of the main elements 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 with UDL principles and teaching methods in a number of ways (see Table 2). 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 3, we give some examples of how the UDL features of graphic organizers can be used to further improve this lesson’s capacity to reach all students. Note that we are not making generalized recommendations for making this lesson more accessible but instead are focusing on ways that graphic organizers, specifically, can help achieve this goal.

Table 2. Existing UDL Elements in “As the Tide Turns: Radio Broadcasts from the Front” Lesson Plan.

| **UDL Guideline/Checkpoint** | 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 which graphic organizer to use. Some students are permitted to choose a task to complete and the tools with which to do so. The lesson plan leaves open the possibility of working with a digital or hard copy version of the graphic organizer. |

Table 3. 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 an appropriate graphic organizer for the task. | Provide background information on graphic organizers and their use (in printed and digital format). |
| Writing 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 their 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 completed, some will provide tips on connecting information. |
| The assigned task is too easy for some students. | Provide students who need more challenge with a list of more complex graphic organizers. |
| The assigned task is boring for some students. | Offer students the option of incorporating images, audio, and video into their graphic organizer; show students how to customize their graphic organizer by using different colors and text styles. |

### Recommendations for Implementation at the Classroom Level

Although UDL applications of graphic organizers 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 25 years in the making, it is an approach that challenges many traditional educational perspectives and practices. Before teachers can implement UDL effectively, they may need to learn a new perspective on 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* [*National Center on Universal Design for Learning*](http://www.udlcenter.org)*.* 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.* The web-based version of the book, [*Universal Design for Learning: Theory and Practice*](http://udltheorypractice.cast.org/login) 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. Additional publications on UDL are listed in the reference section of this document.
* *Enroll in an institute or online course.* [CAST Professional Learning](http://castprofessionallearning.org/) offers many opportunities for educators, teachers, administrators, and organizations to enhance their professional understanding of [Universal Design for Learning (UDL)](http://castprofessionallearning.org/about-udl/) and 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 UDL Center web site includes [UDL Connect](http://community.udlcenter.org/), an online community where educators can communicate, collaborate, and obtain support from other educators who are exploring and teaching with UDL.
* *Integrate technology in education.* The National Education Technology Plan (NETP) guides the use of information and communication technologies in transforming American education. UDL is referred to throughout the Plan to ensure that technology be used to optimize the diversity of learners. In an effort to model UDL, a UDL excerpt of the NETP has been created. The excerpt uses pages 14 through 18 of the report to demonstrate many UDL features.

#### 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 their 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 to serve the 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., HyperStudio5, Kid Pix Deluxe 3X, PowerPoint), graphic organizer software (e.g., Inspiration, Kidspiration), text-to-speech and text-to-image programs (e.g., Universal Reader, Read&Write GOLD, Kurzweil3000, JAWS, Intellitools Classroom Suite), CD-ROM storybooks (e.g., Reader Rabbit’s Reading Development Library), and learning applications (e.g., funbrain.com, 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, survey your classroom and your school media center for a clear idea of computer and projection systems and other technology hardware available to teachers and students. Check into scheduling issues around shared equipment. Additionally, test out web accessibility in your school computer lab(s) and media center(s) as appropriate. If the web is a tool you may use and ask students to access, how available is it? Ask for or take an inventory of your school or district software; find out what’s available and if there are available licenses for computers in your classroom.

Effectively working with and managing technology can be a challenging process, so it is important as well to assess any available technology support. This may come in the form of a school or district help desk, a computer teacher, computer resource specialist, technology integration teacher, etc., 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 and installation of software and hardware. 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, 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 three networks (recognition, strategic and affective), 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 s*et goals* stage of curriculum planning, we recommend that teachers establish the context for instruction. Context is usually driven by or based on state standards, followed by the design of goals for the instructional episode. We recommend that all teachers closely evaluate these to assure alignment and to assure that the means for attaining the goals are separated from the goals and standards.

Next, when designing a UDL lesson, teachers should a*nalyze 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 to 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, build, and share resources, lessons, and collections in [UDL Exchange](http://udlexchange.cast.org) to support instruction guided by the UDL principles.

The third recommended step of the planning process is to a*pply UDL to the lesson or unit.* This includes the goals, methods, assessments, and materials used to implement the lesson. Create a 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 or 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 or unit to assure student access and success. You may obtain additional information about designing UDL methods, assessments, and materials in [*Universal Design for Learning: Theory and Practice*](http://udltheorypractice.cast.org/), Chapter 6.

#### 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 and were 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 helping to prepare 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

[**ERIC Clearinghouse on Disabilities and Gifted Education**](http://www.hoagiesgifted.org/eric/minibibs/eb21.html)This mini-bibliography 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.

[**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://www.readingquest.org/strat/graphic.html)**ReadingQuest offers information on a variety of graphic organizers, concept maps, diagrams, and charts. For each item there is a definition, a description of how it works, and examples.

[**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.

[**UDLTechtoolkit**](https://udltechtoolkit.wikispaces.com/Graphic%2Borganizers)This wikispace maintains a list of free graphic organizers available across different platforms and devices.

[**WriteDesign Online**](http://www.writedesignonline.com/organizers/index.html)The graphic organizers web pages from WriteDesign Online 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.

## References

Alvermann, D. E. & Boothby, P. R. (1986). Children’s transfer of graphic organizer instruction. *Reading Psychology, 7*(2), 87–100.

Anderson-Inman, L., Knox-Quinn, C., & Horney, M. A. (1996). Computer-based study strategies for students with learning disabilities: Individual differences associated with adoption level. *Journal of Learning Disabilities, 29*(5), 461–484.

Boyle, J. R. & Weishaar, M. (1997). The effects of expert-generated versus student-generated cognitive organizers on the reading comprehension of students with learning disabilities. *Learning Disabilities Research & Practice, 12*(4), 228–235.

Bulgren, J., Schumaker, J. B., & Deschler, D. D. (1988). Effectiveness of a concept teaching routine in enhancing the performance of LD students in secondary-level mainstream classes. *Learning Disability Quarterly, 11*(1), 3–17.

Carnes, E. R., Lindbeck, J. S., & Griffin, C. F. (1987). Effects of group size and advance organizers on learning parameters when using microcomputer tutorials in kinematics. *Journal of Research in Science Teaching, 24*(9), 781–789.

Cañas, A. J., Coffey, J. W., Carnot, M., Feltovich, P., Hoffman, R. R., Feltovich, J., & Novak, J. D. (2003). A summary of literature pertaining to the use of concept mapping techniques and technologies for education and performance support. Pensacola, FL: Institute for Human and Machine Cognition. Retrieved from http://www.ihmc.us/users/acanas/Publications/ConceptMapLitReview/IHMCLiteratureReviewonConceptMapping.pdf

CAST (2011).[Universal Design for Learning Guidelines version 2.0](http://www.udlcenter.org/aboutudl/udlguidelines).Retrieved from http://www.udlcenter.org/aboutudl/udlguidelines

Clements-Davis, G. L. & Ley, T. C. (1991). Thematic pre-organizers and the reading comprehension of tenth-grade world literature students. *Reading Research & Instruction, 31*(1), 43–53.

Ciullo, S. & Reutebuch, C. (2013). Computer-Based graphic organizers for students with learning disabilities: a systematic review of literature. *Learning Disabilities Research & Practice, 28*(4), 196-210.

Dexter, D. D. & Hughes, C. A. (2011). Graphic organizers and students with learning disabilities: A meta-analysis. Learning Disability Quarterly, 34, 51–72.

Dexter, D. D., Park, Y. J., & Hughes, C. A. (2011). A meta-analytic review of graphic organizers and science instruction for adolescents with learning disabilities: Implications for the intermediate and secondary science classroom. Learning Disabilities Research & Practice, 26, 204–213.

Darch, C. B., Carnine, D. W., & Kammeenui, E. J. (1986). The role of graphic organizers and social structure in content-area instruction. *Journal of Reading Behavior, 18*(4), 275–295.

Dolan, R. P. & Hall, T. E. (2001). Universal Design for Learning: Implications for large-scale assessment. *IDA Perspectives, 27*(4), 22–25.

Gallego, M. A., Duran, G. Z., & Scanlon, D. J. (1989). Interactive teaching and learning: Facilitating learning disabled students’ transition from novice to expert. *Literacy Theory and Research*, 311–319.

Gardill, M. C. & Jitendra, A. K. (1999). Advanced story map instruction: Effects on the reading comprehension of students with learning disabilities. *The Journal of Special Education, 33*(1), 2–17.

Hall, T. E., Meyer, A., & Rose, D. H. (2012). *Universal Design for Learning in the Classroom: Practical Application.* New York, NY: Guilford Press.

Hector, R. P., Mayer, R. E., & Lopez, M. J. (2013). A computer-based spatial learning strategy approach that improves reading comprehension and writing. *Education Tech Research Dev,* *61*, 819-840.

Herl, H. E., O’Neil, H. F. Jr., Chung, G. K. W. K., & Schacter, J. (1999). Reliability and validity of a computer-based knowledge mapping system to measure content understanding. *Computers in Human Behavior, 15*(3–4), 315–333.

Hudson, P., Lignugaris-Kraft, B., & Miller, T. (1993). Using content enhancements to improve the performance of adolescents with learning disabilities in content classes. *Learning Disabilities Research & Practice, 8*(2), 106–126.

Idol, L. & Croll, V. J. (1987). Story-mapping training as a means of improving reading comprehension. *Learning Disability Quarterly, 10*(3), 214–229.

Merkley, D. M. & Jefferies, D. (2001). Guidelines for implementing a graphic organizer. *The Reading Teacher, 54*(4) 350–357.

Meyer, A., Rose, D. H., & Gordon, D. (2014). Universal design for learning: Theory and practice. Wakefield, MA: CAST.

Moore, D. W. & Readence, J. E. (1984). A quantitative and qualitative review of graphic organizer research. *Journal of Educational Research, 78*(1), 11–17.

Newby, R. F., Caldwell, J., & Recht, D. R. (1989). Improving the reading comprehension of children with dysphonetic and dyseidetic dyslexia using story grammar. *Journal of Learning Disabilities, 22*(6), 373–380.

Novak, J. D. (1990). Concept maps and Vee diagrams: two metacognitive tools to facilitate meaningful learning. Instructional Science, 19(1), 29–52.

Novak, J. D. & Cañas, A. J. (2006). [The theory underlying concept maps and how to construct and use them, technical report IHMC CmapTools](http://cmap.ihmc.us/Publications/ResearchPapers/TheoryUnderlyingConceptMaps.pdf). Pensacola, FL: Institute for Human and Machine Cognition. Retrieved from http://cmap.ihmc.us/Publications/ResearchPapers/TheoryUnderlyingConceptMaps.pdf

Pisha, B. & Coyne, P. (2001). Smart from the start: the promise of Universal Design for Learning. Remedial and Special Education, 22(4), 197-203.

Rose, D. (2001). Universal Design for Learning: Deriving guiding principles from networks that learn. *Journal of Special Education Technology, 16*(2), 66-67.

Rose, D. & Dolan, R. P. (2000). Universal Design for Learning: Associate Editor’s Column. *Journal of Special Education Technology, 15*(4), 47-51.

Rose, D. & Meyer, A. (2000a). Universal design for individual differences. *Educational Leadership, 58*(3), 39-43.

Rose, D. & Meyer, A. (2000b). Universal Design for Learning: Associate Editor Column. *Journal of Special Education Technology, 15*(1), 67-70.

Rose, D. H., & Meyer, A. (2002). *Teaching Every Student in the Digital Age: Universal Design for Learning.* Alexandria, VA: ASCD.

Rose, D. H., Meyer A., & Hitchcock, C., Eds. (2005). *The Universally Designed Classroom: Accessible Curriculum and Digital Technologies*. Cambridge, MA:Harvard Education Press.

Rose, D., Sethuraman, S., & Meo, G. (2000). Universal Design for Learning. *Journal of Special Education Technology, 15*(2), 26-60.

SAS inSchool. (n.d.). *As the Tide Turns: Radio Broadcasts from the Front.* Curriculum unit. SAS Curriculum Pathways.

Scanlon, D., Deshler, D. D., & Schumaker, J. B. (1996). Can a strategy be taught and learned in secondary inclusive classrooms? *Learning Disabilities Research & Practice, 11*(1), 41–57.

Sinatra, R. C., Stahl-Gemake, J., & Berg, D. N. (1984). Improving reading comprehension of disabled readers through semantic mapping. *Reading Teacher, 38*(1), 22–29.

Tindal, G., Nolet, V., Blake, G. (1992). Focus on teaching and learning in content classes. Resource Consultant Training Program, University of Oregon Eugene; Training Module No. 3, 34–38.

Willerman, M. & Mac Harg, R. A. (1991). The concept map as an advance organizer. *Journal of Research in Science Teaching*, *28*(8), 705–712.