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Background Knowledge Instruction and the Implications for UDL Implementation

Curriculum Enhancement

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Background Knowledge Instruction and the Implications for UDL Implementation

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Introduction

Reading to learn is a fundamental literacy skill and one closely tied to success in all areas of the curriculum (Davis & Winek, 1989; Squire 1983; Weisberg, 1988). To master this skill, students must become adept at activating prior knowledge, integrating it with new information, and constructing new understandings. Students who lack sufficient background knowledge or are unable to activate it may struggle to access, participate, and progress throughout the general curriculum.

This document examines the research on instructional approaches to support students' use of background knowledge 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 provides a framework and a context that can help teachers make their background knowledge instruction more broadly effective. By aligning the implementation of background knowledge instruction with UDL, teachers can make a greater impact on student literacy, improving the learning experience for every student in the classroom.

This discussion of background knowledge and UDL begins with an introduction to the topic of background knowledge (presenting a definition of background knowledge and an overview of its curriculum applications) and a discussion of research-supported approaches for developing and activating student background knowledge. In the second part of the paper, the discussion turns to UDL applications of these instructional approaches. This section develops an understanding of UDL and proceeds to identify ways that developing and activating student background knowledge supports UDL at both the theoretical and teacher practice levels, better meeting the needs of diverse students. The document 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 on the Enhancements Literature Review page of the National Center for Accessing the General Curriculum Web site http://www.cast.org/publications/ncac/index.html .

Definition

There is an extensive terminology to describe different kinds of knowledge. Consistency in the use of these terms is a recognized problem; subtle and dramatic differences exist between different people's definitions of the same term (Alexander, Schallert & Hare, 1991; Dochy & Alexander, 1995). The terms background knowledge and prior knowledge are generally used interchangeably. For example, Stevens (1980) defines background knowledge quite simply as "…what one already knows about a subject… (p.151)." Biemans & Simons' (1996) definition of background knowledge is slightly more complex," …(background knowledge is) all knowledge learners have when entering a learning environment that is potentially relevant for acquiring new knowledge (p.6)." Dochy et al. (1995) provide a more elaborate definition, describing prior

knowledge as the whole of a person's knowledge, including explicit and tacit knowledge, metacognitive and conceptual knowledge. This definition is quite similar to Schallert's definition (Schallert, 1982). Thus, while scholars' definitions of these two terms are often worded differently, they typically describe the same basic concept.

Prior knowledge and background knowledge are themselves parent terms for many more specific knowledge dimensions such as conceptual knowledge and metacognitive knowledge. Subject matter knowledge, strategy knowledge, personal knowledge, and self-knowledge are all specialized forms of prior knowledge/background knowledge. The research studies selected and reviewed for this article targeted the parent concepts prior knowledge/background knowledge for study, and in discussing these studies and throughout the remainder of this article, these two terms are used interchangeably.

Applications Across Areas of the Curriculum

By far the most frequent curriculum application of interest for studies of background knowledge is content-area reading, with reading comprehension and recall being the most frequently evaluated learning measures. All but one study in our review investigated the impact of background knowledge or activation of background knowledge on reading comprehension and/or recall; the exception was a study that looked for an impact on writing performance. The overwhelming majority of studies explored outcomes relating to the reading of expository text, with only a few focusing on narrative text. The range of curriculum subject areas targeted for investigation was fairly narrow, including science, social studies, and reading. It is worth emphasizing that in spite of this relatively narrow curriculum area focus, it is likely that findings for these curriculum areas generalize to other areas of the curriculum where reading informational text is also an important activity.

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.

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?
- Is this enhancement more effective for student learning and achievement based on gender?
- 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.

Evidence for Effectiveness as a Learning Enhancement

In the following sections, we discuss the evidence for the effectiveness of instructional strategies to support the use of background knowledge based on a survey of the literature published between 1980 and 2003. This survey incorporated research studies conducted in K–12 education settings. Every attempt was made to be fully inclusive but imperfections in the search strategy and difficulty accessing some materials in timely fashion necessarily limited comprehensiveness.

Prior knowledge has a large influence on student performance, explaining up to 81% of the variance in posttest scores (Dochy, Segers & Buehl, 1999). There is a well established correlation between prior knowledge and reading comprehension (Langer, 1984; Long, Winograd & Bridget, 1989; Stevens, 1980). Irrespective of students' reading ability, high prior knowledge of a subject area or key vocabulary for a text often means higher scores on reading comprehension measures (Langer, 1984; Long et al., 1989; Stevens, 1980). In addition, high correlations have been found between prior knowledge and speed and accuracy of study behavior (reviewed in Dochy et al., 1999) as well as student interest in a topic (Tobias, 1994). Thus, prior knowledge is associated with beneficial academic behaviors and higher academic performance (Table 1).

Table 1
Correlative Studies Showing a Link between Prior Knowledge and Academic Measures

Author(s)	Measure
Langer, (1984); Long et al. (1989); Stevens, (1980)	Reading comprehension
Reviewed in Dochy et al. (1999)	Speed and accuracy of study behavior

It is tempting to conclude from observations such as these that prior knowledge promotes better learning and higher performance, but different research methods are needed to establish such a causal relationship. In the sections below we consider research findings that speak directly to the ability of prior knowledge to influence academic outcomes. In the first section we discuss research findings from studies that have investigated instructional approaches for building students' prior knowledge. In the second section we discuss findings from research studies that have investigated instructional approaches for helping students activate prior knowledge. In the course of these discussions we identify instructional approaches that the research indicates can effectively support students' use of background knowledge and improve their academic performance.

Evidence for Effectiveness of Strategies for Building Prior Knowledge

The research literature addresses several instructional approaches for building prior knowledge (Table 2) the most frequently studied being direct instruction. Direct instruction on background knowledge can significantly improve students' comprehension of relevant reading material (Dole, Valencia, Greer & Wardrop, 1991; Graves, Cooke & Laberge, 1983; McKeown, Beck, Sinatra & Loxterman, 1992; Stevens, 1982). For example, in one study, students who received direct instruction on relevant background knowledge before reading an expository text demonstrated significantly greater reading comprehension than peers who received direct instruction on an irrelevant topic area (Stevens, 1982). Dole et al. (1991) extended these findings,

showing that teaching students important background ideas for an expository *or* narrative text led to significantly greater performance on comprehension questions than did no pre-reading background knowledge instruction. By building students' background knowledge teachers might also help to counteract the detrimental effects that incoherent or poorly organized texts have on comprehension (McKeown et al., 1992).

Table 2
Instructional Approaches to Help Students Build Background Knowledge

Approach	Author(s)
Direct Instruction	Dole et al. (1991); Graves & Cooke (1980); Graves et al. (1983); McKeown et al. (1992); Stevens (1982)
Previewing	Graves et al. (1983)
Field Experiences	Koldewyn (1988)

Direct instruction on background knowledge can be embedded into an approach such as previewing, where students are presented with introductory material before they read specific texts. Such introductory material may include important background information such as definitions of difficult vocabulary, translations of foreign phrases, and explanations of difficult concepts. For example, in a study by Graves et al. (1983), students were given previews of narrative texts that included a plot synopsis, descriptive list of characters, and definitions of difficult words in the story. Thus, students were given both a framework for understanding the stories and important background information. Students not only liked the previews but made significant improvements in both story comprehension and recall. Results of an earlier study by Graves et al. (1983) demonstrated a similarly beneficial impact of previews incorporating historical background for the text.

As an alternative to a direct instruction approach, teachers might consider one more indirect, such as immersing students in field experiences through which they can absorb background knowledge more independently. Koldewyn (1998) investigated an approach that combined reading trade books, journal keeping, fields trips that put students in authentic experiences related to their reading, and follow-up Language Experience activities (Koldewyn, 1998). Qualitative observations in Koldewyn's report reflect positively on the technique. However, the data are too preliminary to clearly establish the effectiveness of the approach or clarify which of its elements are most valuable.

By building students' background knowledge teachers may also be able to indirectly influence other aspects of academic performance such as writing. For example, Davis et al. (1989) found that students felt better prepared to write a research paper when they took part beforehand in an extended course of building background knowledge through individual research and in-class sharing and discussion (Davis et al., 1989). While this study does not show any direct impact on writing quality, it might be expected that improving students' sense of preparedness might raise their engagement and/or motivation, translating into better performance.

Factors Influencing the Effectiveness of Strategies for Building Prior Knowledge

The studies discussed above provide corroborating support for the effectiveness of direct instruction on background knowledge as a means to build reading comprehension. The degree of effectiveness of this approach could presumably be influenced by a variety of factors including student characteristics, duration of instruction, grade level, and ability level. None of these factors have been routinely investigated, and the studies we have reviewed do not identify any of them as notably influential. On the contrary, these studies support the effectiveness of direct instruction on background knowledge under a range of conditions. Research by Stevens (1982), Dole et al. (1991), and Graves et al. (1983) demonstrates effectiveness for grades five, seven, eight, and ten and with students with poor reading ability as well as students from "average classes." After controlling for reading ability in the sample, Stevens (1982) still reported a significant effect of prior knowledge building on reading comprehension. Thus, this approach appears to be effective for a range of grade levels and student populations. Additional research is needed to extend these findings and investigate more comprehensively the factors that might influence the success of direct instruction of background knowledge.

There is a great deal of corroboration in this literature that computer simulations have considerable potential in helping students develop richer and more accurate conceptual models in science and mathematics, although some of these studies have limitations with regard to research quality.

Evidence for Effectiveness of Strategies for Activating Prior Knowledge

There is a good amount of research investigating the effectiveness of instructional strategies for activating prior knowledge as a means to support students' reading comprehension. As a whole, the research base provides good evidence to support the use of prior knowledge activation strategies; prior knowledge activation is regarded as a research-validated approach for improving children's memory and comprehension of text (Pressley, Johnson, Symons, McGoldrick & Kurita, 1989). There are a variety of strategies for helping students to activate prior knowledge (Table 3). We have divided this review into six sections, each addressing a different approach.

Table 3
Instructional Approaches for Activating Prior Knowledge

Approach	Supporting Research Studies
Reflection and recording	Carr & Thompson, (1996); Peeck, van den Bosch, & Kreupling, (1982); Smith, Readence, & Alvermann, (1983); Spires & Donley, (1998); Walraven & Reitsma, (1993)
Interactive discussion	Dole et al. (1991); Schmidt & Patel, (1987)
Answering questions	King, (1994); Hansen & Pearson, (1983); Pflaum, Pascarella, Auer, Augustyn & Boswick, (1982); Pressley, Wood, Woloshyn, Martin, King & Menke, (1992); (reviews multiple studies)
K-W-L	Ogle, (1986)
CONTACT-2	Biemans & Simons, (1996); Biemans, Deel & Simons, (2001)
Interpretation of topic-related pictures	Croll, Idol-Maestas, Heal & Pearson, (1986)

Prior knowledge activation through reflection and recording. One of the simplest methods for helping students activate background knowledge is to prompt them to bring to mind and state, write down, or otherwise record what they know. Asking students to answer a simple question such as "What do I already know about this topic" orally or on paper is a straightforward way to do this. The reported effectiveness of this simple strategy is quite good, with five studies (Carr et al., 1996; Peeck et al., 1982; Smith et al., 1983; Spires et al., 1998; Walraven et al., 1993) in our review reporting some beneficial impact relative to control treatments, and just one study (Alvermann, Smith & Readence, 1985) reporting only no benefit or a negative impact. Reading comprehension was the most frequently measured outcome in these studies, but some studies also report beneficial effects on text recall (Peeck et al., 1982; Smith et al., 1983).

Activating relevant prior knowledge by expressing in some form what one already knows about a topic has been demonstrated to be more effective than activating irrelevant background knowledge (Peeck et al., 1982) or not activating any background knowledge (Carr et al., 1996; Smith et al., 1983; Spires et al., 1998) at improving text recall and/or comprehension. Spires et al. (1998) found that activating background knowledge through reflection and oral elaboration during text reading was a more effective strategy than taking notes on main ideas and their corresponding details. Walraven et al. (1993) found equally good effectiveness when embedding instruction in prior knowledge activation within a Reciprocal Teaching approach. Strategy instruction that incorporated direct instruction in prior knowledge activation promoted student reading comprehension more effectively than the regular program of instruction. However, Reciprocal Teaching without instruction in prior knowledge activation was no less effective.

Teachers may be able to improve the effectiveness of a brainstorming approach to prior knowledge activation by helping students to organize their prior knowledge into a semantic map (Englert & Mariage, 1991). Englert et al. (1991) found that organizing prior knowledge in this way before reading led to significantly greater free written recall of the text than did brainstorming alone.

A weakness in this research base is the failure to characterize the duration of the learning effects, with most studies presenting only a minimal delay between instruction and testing. Only Spires et al. (1998) and Walraven et al. (1993) looked for effects at delayed time points, but both found that reading comprehension gains were maintained for roughly 4 weeks after instruction, suggesting that re-statement of prior knowledge can produce a lasting impact.

There are important subtleties to some of these findings indicating an influence by various factors on the effectiveness of this prior knowledge activation strategy. Some studies have shown, for example, that this strategy has a different impact on reading comprehension depending on the text features (Carr et al., 1996; Peeck et al., 1982); familiar vs. unfamiliar text, consistent vs. inconsistent with prior knowledge. This issue is an important one and will be discussed in the Factors Influencing Effectiveness section below.

Prior knowledge activation through interactive discussion. With the general approach discussed in the previous session, students, once prompted, record prior knowledge with little or no discussion or other stimulation from teacher or peers. An alternative to this is an interactive approach, where student reflection on prior knowledge is supplemented with interactive discussion. For example, Dole et al. (1991) designed an intervention where students

reflected on and recorded their prior knowledge on a topic and then engaged in a group discussion of the topic, during which the teacher encouraged them to contribute knowledge to complete a semantic map. This approach was determined to be more effective at promoting reading comprehension than no pre-reading instruction. However, it was less effective than direct instruction on the information needed to understand the text. Thus, it is not clear that an interactive approach would have any advantage over direct instruction.

The robustness of interactive approaches is not always very impressive. For example, findings from Schmidt et al. (1987) suggest that topic area novices may significantly benefit from this kind of approach, whereas subject area experts may not. In this study, students activated background knowledge by gathering in small groups to analyze a problem and then proposing and discussing solutions (Schmidt et al., 1987). Results of a study by Langer (1984) were inconsistent, showing no reliable advantage to participating in a pre-reading activity called the Pre Reading Plan (PReP), where students are trained to free associate on key vocabulary words, reflect on these associations, discuss their associations as a group, and then reformulate their knowledge based on the discussion. Students' performance on comprehension tests was not consistently better than that of peers who engaged in general discussion of the topic before reading or took part in no pre-reading activity.

Thus, consistently solid evidence to support the use of an interactive approach to prior knowledge activation is lacking. Based on the studies we reviewed, it is not clear that the added effort involved in such an approach improves upon the results of direct instruction in background knowledge. However, it is also possible that the apparent advantage of direct instruction in background knowledge over an interactive approach derives only from its greater familiarity to students (Dole et al., 1991). This is a possibility that merits investigation. Further research is also needed to better determine the conditions under which an interactive approach is beneficial—e.g., does it differently affect students with different levels of subject area expertise. It should also be noted that there are many possibilities for designing an interactive approach, and we have touched on only a few of them.

Prior knowledge activation through answering questions. Research by Rowe & Rayford (1987) suggests that teachers can facilitate student activation of background knowledge by having them answer questions before and/or while they read new material (Rowe et al., 1987). They analyzed student responses to a series of 3 pre-reading purpose setting questions. Students were shown 3 purpose questions from the Metropolitan Achievement Test and asked to make predictions about the passage and end-of-passage questions that might go with each question. Students were also asked to put themselves in the test-taker's position and describe what they would try to find out while reading the passage. Analysis of the students' responses suggested that students were able to activate background knowledge under these conditions, an indication that purpose questions may be helpful cues for activating background knowledge.

Extending this work, studies have investigated whether activating background knowledge through question answering improves reading comprehension. It has been theorized that generating answers to questions facilitates deep processing and high level knowledge construction, which in turn facilitate learning (King, 1994; Pressley et al., 1992). Experimental findings support this theory. First, King (1994) found that a guided reciprocal peer questioning and answering approach, where students were trained to study new material by asking and answering each other's self-generated questions, promoted significantly better lesson

comprehension than untrained questioning. Interestingly, King's data show that questioning focused on linking prior knowledge with lesson material led to more maintained high performance than did questioning focused on making connections within the lesson material. Thus, instruction in peer questioning and explaining through connecting text to prior knowledge may be a particularly effective question answering strategy for improving comprehension.

Pflaum et al. (1982) investigated a somewhat different question-based method for prior knowledge activation where students were asked, before and during reading, five questions about the topic in the text (Pflaum, et al., 1982). The questions prompted students to define the topic, make associations between the topic and their background knowledge, identify the role and location of the topic matter, and comment on the topic's importance. Data suggest that this strategy may be effective for some readers and not others, depending on their reading ability. Similarly, Hansen et al. (1983) found that having students make associations between the text and their background knowledge and predictions about what would happen in the text, together with providing them with inferential questions to discuss after reading the text, significantly improved their comprehension as compared to students who did not engage in these activities. Effects also differed according to reading ability.

A review by Pressley et al. (1992) builds a strong case for the hypothesis that question answering approaches can increase learning. After reviewing a large number of research studies, they conclude that asking students to generate explanatory answers to questions about content to be learned can facilitate learning of the material. The reviewed approaches included guided reciprocal peer questioning, asking students to respond to pre-questions accompanying text, elaborative interrogation where students generate elaborations in response to why questions about to-be-learned facts, and asking students to generate explanatory answers to questions as part of group learning. Pressley et al. (1992) emphasize that not all questioning interventions are effective; the most effective questioning requires deep processing of the to-be-learned material and relating it to prior knowledge.

The K-W-L strategy for activating prior knowledge. Ogle (1986) developed a strategy for helping students access important background information before reading nonfiction. The K-W-L strategy (accessing what I Know, determining what I Want to find out, recalling what did I Learn) combines several elements of approaches discussed above. For the first two steps of K-W-L, students and the teacher engage in oral discussion. They begin by reflecting on their knowledge about a topic, brainstorming a group list of ideas about the topic, and identifying categories of information. Next the teacher helps highlight gaps and inconsistencies in students' knowledge and students create individual lists of things that they want to learn about the topic or questions that they want answered about the topic. In the last step of the strategy, students read new material and share what they have learned. Informal evaluations indicate that the K-W-L strategy increases the retention of read material and improves students' ability to make connections among different categories of information as well as their enthusiasm for reading nonfiction (Ogle, 1986). The approach has been recommended by teaching professionals (Bean, 1995; Carr & Ogle, 1987; Fisher, Frey & Williams, 2002), but it has not been rigorously tested.

CONTACT-2, computer-assisted activation of prior knowledge. The approaches discussed so far involved traditional materials such as paper and pencil and face-to-face discussion. Biemans & Simons (1996) investigated a computer-assisted approach for activating conceptions during reading, called CONTACT-2. CONTACT-2 assists students in searching for preconceptions, comparing and contrasting these preconceptions with new information, and

formulating, applying, and evaluating new conceptions. Students working with CONTACT-2 developed higher quality conceptions than students in a no activation group, and this advantage was still apparent at a 2-month follow-up. More recent research suggests that the key component of CONTACT-2 is comparing and contrasting new and existing knowledge, which most accounts for students' successful performance on lesson tests (Biemans, et al., 2001). These findings reinforce the idea that integrating new information with prior knowledge is a valuable learning strategy and suggests that a computer-assisted approach can be as successful as a teacher-directed one.

Prior knowledge activation through interpretation of topic-related pictures. Croll, et al., (1986) describe a unique approach that combines building and activating prior knowledge. The approach entails training students to interpret topic-related pictures (Croll, et al., 1986). Two students trained in this strategy significantly improved reading comprehension for both pictures and text. The author suggest this to be an effective approach, but the limited sample of two students and lack of a control group make any such claims tentative and preliminary at best. Moreover, there has been no subsequent research to help validate these findings.

Factors Influencing the Effectiveness of Strategies to Activate Prior Knowledge

Grade level. Students across a wide range of grade levels, spanning first to tenth grade, are represented in the studies we have discussed, although most studies sampled students toward the middle of this range, in grades five and six. Looking across these studies there is no apparent relationship between study outcome and the grade level sampled. On the contrary, our review suggests that prior knowledge activation strategies can be effective with K–8 students.

Student characteristics. Students bring to a text different levels of topic area familiarity, and this is understandably a factor of interest when investigating the effectiveness of prior knowledge activation strategies. Two studies investigated the possibility that students' level of familiarity with the topic matter might influence the effectiveness of prior knowledge activation strategies. Carr et al. (1996) discovered a different pattern of results depending on the familiarity of the text topic to the student participants. When reading unfamiliar passages, students that were asked to state their prior knowledge on the text topic significantly outperformed students who were not asked to state prior knowledge. However, when reading familiar passages, only a subset of the student population, age-matched students without disabilities, benefited from prior knowledge activation. Similarly Schmidt et al. (1987) found that novices and experts on passage subject matter responded differently to a prior knowledge activation strategy. Novices demonstrated better performance after having taken part in interactive prior knowledge activation than after having activated irrelevant prior knowledge, while experts showed no benefit. These findings both suggest that students with more limited knowledge of the topic area may more consistently benefit from prior knowledge activation strategies.

Of course, readers may be familiar with a topic area—even have considerable knowledge of it—without that knowledge being accurate. A question of interest is whether or not prior knowledge activation is advantageous when students are activating false preconceptions. The consensus from the three studies we reviewed on this topic is that prior knowledge activation may in fact interfere with learning when learners are confronted with material at odds with their preconceptions. When text is inconsistent with prior knowledge, students that mobilize this prior knowledge perform significantly more poorly on tests of recall and comprehension than do peers

who do not activate prior knowledge (Alvermann et al., 1985; Smith et al., 1983). Lipson (1982) commented that students tend to disregard passage information inconsistent with their prior knowledge and therefore construct more accurate meaning when lacking prior knowledge versus having inaccurate prior knowledge (Lipson, 1982). Although Peeck et al., (1982) reported a beneficial effect of activating incongruous prior knowledge, they did not randomize group assignment, raising the possibility that pre-existing differences in recall ability confound their findings. Moreover, a more recent review article Pressley, et al. (1989) minimizes the importance of these findings by reporting that there are more studies showing inconsistent prior knowledge to be detrimental than beneficial (Pressley et al., 1989).

Weisberg (1988) claims that students with disabilities, as a group, demonstrate a considerable over reliance on prior knowledge when text material is inconsistent with their preconceptions. This raises another issue, which is whether a student's educational group or disability status influences the effectiveness of prior knowledge activation strategies. Many of the studies in our review included students from different educational groups, most often students with different reading levels (Biemans et al., 2001; Langer, 1984; Smith et al., 1983; Spires et al., 1998) but also students with and without learning disabilities (Carr et al., 1996; Croll et al., 1986; Pflaum et al., 1982; Walraven et al., 1993). A few of these studies analyzed the data in a way that would reveal differences in responsiveness to prior knowledge activation across educational groups (Carr et al., 1996; Langer, 1984; Pflaum et al., 1982). Their findings suggest that the effectiveness of prior knowledge activation strategies may in fact differ across different student populations.

For example, Pflaum et al. (1982) found that "same age normal" students significantly benefited from prior knowledge activation, whereas "young age-matched normal" students and students with disabilities did not (instead these students showed significant improvement with sentence aids). Langer (1984) found that the Pre Reading Plan (PReP) prior knowledge activation activities were not effective for below-level readers. On-level readers demonstrated the greatest and most consistent benefit, and above-level readers a less consistent benefit. In contrast, Hansen et al. (1983) found that prior knowledge activation was effective for poor readers but not good readers. A possible explanation for these opposing findings is that the impact of prior knowledge activation on students from different educational groups depends in part on the topic familiarity (Langer, 1984). In summary, a range of data suggests that it is very important to consider learners' unique strengths, weaknesses, and preferences when selecting instructional approaches.

Text characteristics. The studies we reviewed used both expository and narrative texts to investigate the impact of prior knowledge activation strategies on learning; however, the vast majority used only expository texts. These studies provide strong evidence that prior knowledge activation strategies are effective at improving comprehension of informational texts. Although very few studies investigated the use of these strategies when reading narratives, two studies by Carr et al., (1996) and Dole et al., (1991) suggest that prior knowledge reflection and recording and interactive prior knowledge activation, respectively, may be beneficial when working with this kind of text. Additional research may help to clarify any differences in effectiveness of prior knowledge activation when working with different kinds of text.

Table 4
Factors Influencing the Effectiveness of Prior Knowledge Activation Strategies

Approach	Student Characteristics
Topic familiarity	Students with more limited knowledge of the topic area may more consistently benefit from prior knowledge activation strategies.
Accuracy of prior knowledge on a topic	For learners with inaccurate preconceptions, prior knowledge activation may interfere with learning.
Educational group	Students with disabilities may over rely on prior knowledge when text material is inconsistent with their preconceptions. Students reading at different levels may respond differently to prior knowledge activation strategies.

Summary

Supporting students as they read to learn is an important instructional goal. Research studies have clearly established the importance of background knowledge to reading and understanding a variety of texts. Research studies also provide direct evidence that instructional strategies designed to support the accumulation and activation of prior knowledge can significantly improve student reading comprehension of informational texts. Thus, by implementing instructional strategies to support students' background knowledge, teachers can better support their content area learning.

The best-supported approaches emerging from this review are direct instruction on background knowledge, student reflection on and recording of background knowledge, and activation of background knowledge through questioning. However, there are other promising approaches, including the computer supported approach CONTACT-2 (Biemans & Simons, 1996) that merit additional research. The impact of such approaches on general literacy is another issue worth further study. Although a few studies support the effectiveness of background knowledge instruction for improving student comprehension of narrative texts, more research is needed.

Another important conclusion that emerges from the research is the importance of considering student characteristics (Table 4), including their familiarity with a topic area and the accuracy of their prior knowledge, in selecting approaches to support the activation of background knowledge. For example, students who hold inaccurate preconceptions may not be helped by prior knowledge activation strategies. For these students, instruction that clarifies and/or expands prior knowledge may be important. By effectively selecting and implementing instructional strategies to build and/or activate background knowledge, teachers can better support all students on their way toward reading to learn and succeeding throughout the curriculum.

The next section of this report introduces the reader to the theory and research behind UDL and investigates the links between UDL and instructional strategies to support students' use of background knowledge. Additionally, methods and materials that can be used to support the implementation of background knowledge instruction in concert with the principles of UDL are identified. Finally, a set of guidelines for UDL implementation are provided, including a listing of Web resources that provide further information on the content 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. 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 2).

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 2. The 3 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 3, 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 learning context
- Offer choices of content and tools
- Offer adjustable levels of challenge
- Offer choices of rewards

Figure 3. 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, audio, 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 background knowledge instruction aligns with each of the 3 UDL principles. Within the context of these teaching methods we'll show how instruction on background knowledge can support individualized recognition, strategic, and affective learning.

Background Knowledge Instruction and the Three Universal Design for Learning Principles

As teachers support students in the development and activation of background knowledge, they also support UDL. In the following sections, we discuss points of intersection between prior knowledge instruction and the three UDL principles and their associated broad teaching methods (identified by italics). There is a mutually supportive relationship between background knowledge instruction and UDL. Supporting background context is itself a UDL teaching method and therefore directly serves UDL by supporting students' diverse recognition abilities and preferences. In addition, the incorporation of UDL teaching methods into background knowledge instruction can help to improve its effectiveness. In the sections to follow, we provide some specific examples.

Recognition learning. The first UDL principle recommends multiple, flexible methods of presentation to evenly support students' varied recognition networks. Background knowledge instruction can play a significant role in accomplishing this goal. In fact, the fourth UDL teaching method for supporting students' recognition networks is to *support background context*.

The knowledge students bring to a new situation varies in both quantity and kind—as does their ability to call upon this knowledge appropriately. Weaknesses in these areas can present a barrier to recognition learning. Thus, to even the playing field teachers need to help fill in gaps in students' background knowledge and help them to activate this knowledge in response to new information. In this respect, all of the research-supported instructional strategies identified in the beginning of this article can help to minimize barriers to recognition learning and maximize every student's learning.

When providing background knowledge instruction it is important to take a flexible approach that can adapt to individual student's strengths, weaknesses, and preferences. Implementing other UDL teaching methods can help teachers to individualize background knowledge instruction effectively. For example, students benefit from being offered *multiple examples* of a pattern—this helps them to extract the key features of a pattern and offers individual students the chance to select and focus on examples most effective for him or her. Thus, a teacher providing direct instruction of background knowledge for a text on mammals, for example, might present examples that draw from a range of mammalian species. When presenting these examples a teacher might also directly *highlight the critical features*, perhaps using a graphic organizer or pictures to demonstrate meaningful commonalities.

This raises another important point, which is that students vary in their ability to process different patterns, making it essential that teachers *use different media and formats* during background knowledge instruction. During direct instruction of background knowledge this might mean showing students text, images, and video as well as immersing students in field experiences. To help students activate background knowledge we have seen that both text-based approaches and an image analysis approach (Croll et al., 1986) can be effective. A teacher could implement both approaches to ensure that students who might struggle with text or images have an effective means to activate background knowledge.

Strategic learning. Students' strengths, weaknesses, and preferences in the area of strategic learning vary as widely as they do for recognition learning. Thus, it is equally important to satisfy the second UDL principle and provide multiple, flexible, methods of expression and

apprenticeship. The UDL teaching methods to support strategic networks guide the diversification of skills and strategies instruction and are a valuable way to increase the effectiveness of background knowledge instruction.

As students work to master a new skill they require *flexible models of skilled performance*. Just as students can extract critical features of a pattern from multiple examples, so can they extract the critical features of a process when viewing multiple models. Different students may find different models most effective. Thus, when modeling background knowledge activation it is beneficial for teachers to diversify their examples. This might be accomplished through a mix of teacher- and peer-modeling, and by modeling different approaches to activating background knowledge such as questioning, prediction, free associating, image analysis and brainstorming.

Another UDL Teaching Method to bear in mind during instruction in how to activate background knowledge is *providing opportunities to practice with supports*. Complex skills are difficult to master unless students have a chance to focus on individual steps one at a time. Teachers can facilitate the automation of background knowledge activation by offering students the chance to practice with scaffolds. Depending on the learner's level of need and his or her preferences, scaffolds could take the form of guide sheets explaining the procedure, a one-on-one review with the teacher, access to a peer expert, or a simplifying step such as dividing the topic area into subtopics to be dealt with one at a time.

As students continue to practice, it is also essential to *provide ongoing, relevant feedback*. This, too, could take a variety of forms to meet different students' needs and preferences: one on one teacher or peer feedback, a group discussion to reveal gaps in knowledge or misconceptions, or perhaps a self-test. Last, when asking students to demonstrate background knowledge, *offer flexible opportunities for demonstrating skill* such as an oral presentation, composition, hands-on demonstration, or collage. This helps to ensure that strengths and weaknesses unrelated to the background knowledge itself do not confound students' performance.

Affective learning. Students vary widely in their preferences and inclinations, making it important to give students the flexibility of pursuing their own interests. Thus, the 3rd UDL principle recommends that we support affective learning by providing multiple, flexible options for engagement. This too is an important facet of effective background knowledge instruction.

Offering choices of content and tools is one way for teachers to fuel every student's enthusiasm for developing and activating background knowledge. Although by design the content area is often restricted, in some cases there is leeway to offer students choice. For example, when developing background knowledge on a fairly general topic such as poetry or war, students could be given the option of focusing on particular examples of interest. With respect to tools, students might be given the option of working with pictures or text; or of recording knowledge on computer, etc.

Challenge is another factor influencing students' motivation to learn. When challenged too much or too little, students tend to disengage. But by *providing adjustable levels of challenge* teachers can help ensure that each student is optimally motivated. During background knowledge instruction this can be accomplished by offering flexible supports that can be optionally accessed. Computer programs would be particularly useful in this regard by incorporating a range of supports that could be accessed or not, depending on the individual. Students might also select from teacher and peer support, templates for recording knowledge, and graphic organizers for keeping track of and organizing knowledge.

A third advantageous method for engaging students is *offering a choice of learning context*. Students thrive in different contexts—minimally or maximally structured, individual or group settings, inside or outside the classroom. Background knowledge instruction can be effective in all of these contexts, and students benefit from having a choice. For example, a student could learn by reading a book in class or taking a field trip outside the classroom. One student might pair up with a peer, while another might work by himself, and another might engage in large group discussion. By diversifying the options, teachers can reduce affective barriers to success.

Examples

In the above section, we have highlighted the many ways that background knowledge instruction supports the three UDL principles and aligns 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 two examples of UDL application of background knowledge instruction, one from CAST work, and one from outside work. For the CAST example, we highlight the ways that background knowledge supports converge with UDL teaching methods. For the outside example, we identify general UDL features in the lesson and then highlight ways that background knowledge instruction could be better integrated with UDL to reduce lingering barriers.

CAST's universally-designed hypertexts to improve reading comprehension.

Funded by the U.S. Department of Education, Office of Special Education Programs; and other foundations, CAST has investigated the benefits of a computer-supported reading environment to help students develop reading comprehension strategies and learn to read for understanding. Merging reciprocal teaching (Palincsar & Brown, 1986) and UDL, CAST's research prototypes provide comprehension strategy instruction in engaging and supported digital environments. These prototypes embed reading comprehension strategy instruction directly into literature. As students read, with the option of using text-to-speech to access content, they encounter prompts to stop and apply reading comprehension strategies. Instruction is individualized through leveled supports and optional scaffolds, which include background knowledge aids. Below is a list of different background knowledge supports in the various prototypes (Figure 4). Figure 5 shows an example of one of these supports, a timeline developed for the book "Martin Luther King, Jr., and the March on Washington" by Frances E. Ruffin. Tom Snyder Productions, in cooperation with CAST, developed *Thinking Reader*, a software program based on these prototypes.

Background Knowledge Supports in CAST's Universally Designed Hypertexts

- Help page with information on reading comprehension strategies
- Multimedia glossary
- Multimedia glossary in both Spanish and English
- Links to online resources providing background knowledge for the text
- PowerPoint providing background information
- Maps of the story setting
- Story timeline
- Maps of the main character's journey
- Publisher's notes
- Video and photo essay offering a connection between the story and the real world

Figure 4. Listing of background knowledge supports available in CAST's universally designed hypertexts.

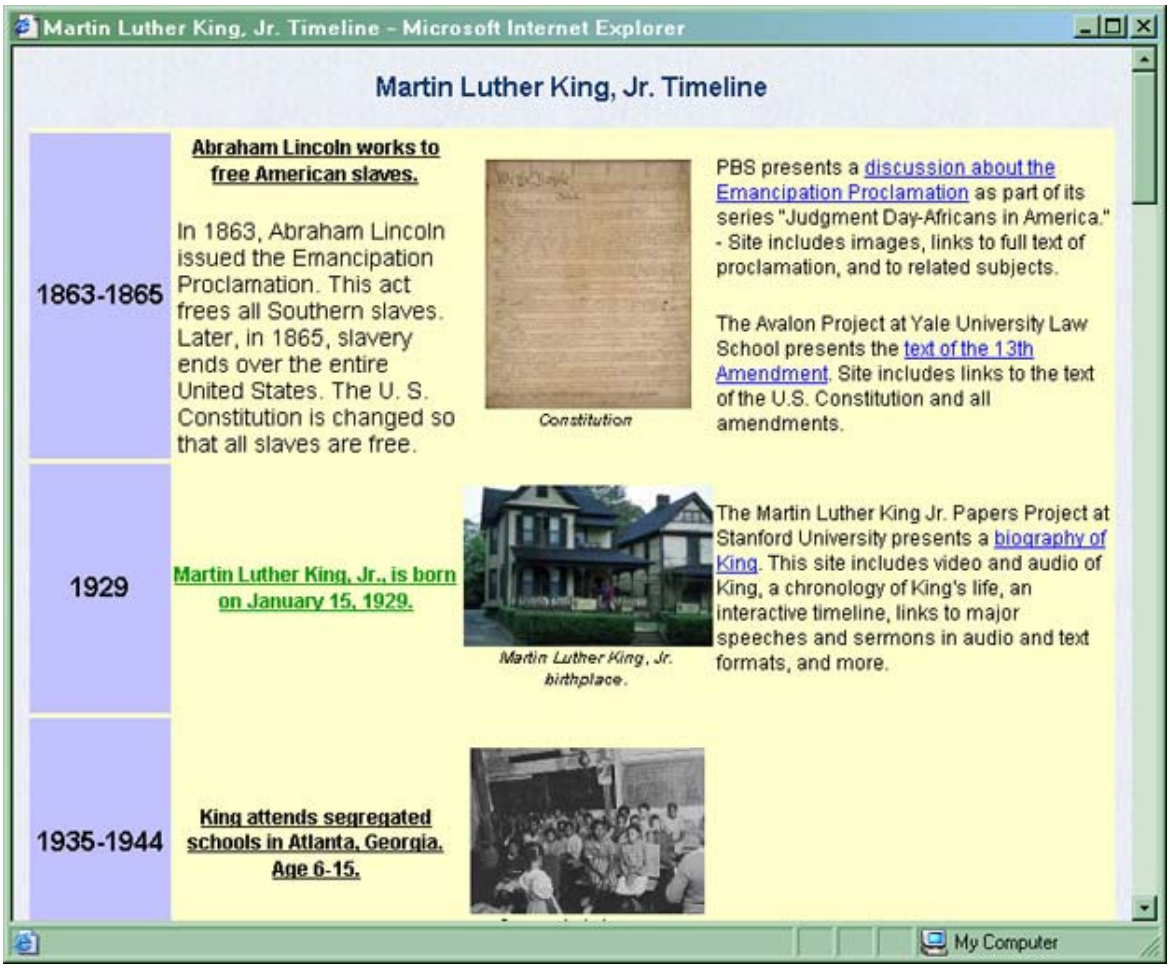

Figure 5. Part of a timeline developed for "Martin Luther King, Jr., and the March on Washington" to support readers' background knowledge.

In addition to directly supporting background context, these aids reinforce a number of other UDL teaching methods. Table 5 illustrates how UDL Teaching Methods and Thinking Readers' background knowledge aids converge.

Table 5
UDL Applications of Thinking Reader and Thinking Reader Research Prototypes

UDL Teaching Method	Supportive Lesson Feature(s)
Provide multiple examples	The multimedia glossary offers multiple photo illustrations for vocabulary words. Web links to resources offer students multiple examples of key facts and concepts.
Highlight critical features	The Maps, Timeline, and Character Journey highlight critical features of the text related to setting and characters. The PowerPoint and Web links to resources highlight other critical features related to the text.
Provide multiple media and formats	The multimedia glossary offers text and illustrations. The Video and Photo Essay provide redundant information in multiple media and formats. Maps and Character Journey present story information in another medium and format. Vocabulary support is provided in English and Spanish in *Thinking Reader*.
Support background context	See Table 6.
Provide opportunities to practice with supports	All the background knowledge aids provide optional support for students, who can access them or not, as they wish.
Offer adjustable levels of challenge	Students can adjust the level of challenge by varying their consultation of the background knowledge supports.
Offer choices of content and tools	The variety of background knowledge aids provide students with the opportunity to choose among different content and tools.

Building prior knowledge lesson plan from CyberBee: Building Prior Knowledge

http://www.infotoday.com/MMSchools/may02/cybe0502.htm

Kathleen Waugamann, a fourth grade teacher, developed this lesson plan for her social studies curriculum. The main content objective of the lesson plan is responding to text, in this case the book *Teammates* by Peter Golenbock, a story about the friendship between Brooklyn Dodgers' Jackie Robinson and Pee Wee Reese in an era of segregation. As a prelude to reading the book, students visit Web sites to view baseball cards, and they view and discuss a PowerPoint presentation depicting segregation, the Klu Klux Klan, violence against blacks, and changes

made during the Civil Rights Movement. Then after reading and discussing the book, students visit Web sites to retrieve more information, create a Venn diagram to compare the black and white baseball leagues, and produce a PowerPoint presentation and word document to show a deeper understanding of the story.

This lesson plan supports UDL principles in some fundamental ways, most prominently by using multimedia technology such as Microsoft Word/Digital Photographs, PowerPoint, Web sites, and Microsoft Publisher to help students build and activate background knowledge (Table 6).

Table 6
Existing UDL Elements in "Building Prior Knowledge" Lesson Plan

UDL Teaching Method	Supportive Lesson Feature(s)
Provide multiple examples	To identify with the notion of being a baseball player, students visit multiple Web sites to view multiple examples of baseball cards. Multiple Web sites are pre-selected for later in the lesson when students retrieve more information relevant to the story. Multiple examples are used to illustrate the topic of segregation in the PowerPoint slideshow.
Highlight critical features	The teacher highlights critical features of the story with a thematic PowerPoint slideshow.
Provide multiple media and formats	The teacher provides background information in the form of Web site material, printed text, images, and digital photographs.
Support background context	The teacher develops and activates student background knowledge in a variety of ways (visiting Web sites, making baseball cards, viewing a slideshow, consulting other resources, generating Venn diagrams).
Provide opportunities to practice with supports	The teacher scaffolds the research process by providing suggested Web resources.
Provide ongoing, relevant feedback	Students have the opportunity to get feedback on their knowledge state during group discussion of the PowerPoint presentation.
Offer choices of content and tools	Students can choose among Web sites and library resources and have the latitude to focus on different aspects of the story.

There are additional ways to minimize barriers in this lesson using a combination of UDL teaching methods and background knowledge instruction. For example, understanding Web content requires a kind of Internet literacy that can be a recognition barrier for some students. Teachers can reduce this barrier by providing students with rudimentary knowledge about how Web pages are organized and the different types of content they contain, and introducing them to vocabulary that is common on the Web. In Table 7, we give some additional examples of how

UDL can be built in to the methods of background knowledge instruction to reduce recognition, strategic, and affective barriers and 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 the background knowledge components, specifically, can be improved.

Table 7
Strategies to Make Background Knowledge Instruction in "Building Prior Knowledge" Lesson Plan more UDL

Barrier	UDL Strategy
Recognition Barriers	
Need for conceptual knowledge about what a Web site is and how to navigate it as well as familiarity with Web terminology.	Provide students with background knowledge on Web sites and Web terminology and a way for accessing this background knowledge while using the Web.
Seeing or decoding the text and/or images on the pre-selected Web sites.	Provide students who cannot see or read the text/images on the Web sites—or who do not like this presentation mode—with the option of using a screen reader to access the content as speech. Pre-select Web sites with different reading levels of text and assign Web sites accordingly. Offer the option of using other media such as video and audio.
The amount of material on the Web sites can be overwhelming and there are many distractors.	Give students the option of bringing in their favorite baseball cards instead of finding them/viewing them on the Web. Provide supports to help keep students stay on task when reading on the Web and help them choose between relevant and irrelevant parts of a Web page.
Strategic Barriers	
Keeping track of information	Provide students with note-taking tools for research on or off the Web.
Creating a Venn diagram	Provide scaffolds for students who need them, such as a partially filled in Venn diagram, the opportunity to work with a peer coach, or models of expert performance.
Lack of awareness of how well they are succeeding with research tasks	Provide students with regular feedback (teacher feedback, peer feedback, self-test…).
Affective Barriers	
Research process is boring.	Provide students with the option of finding their own resources such as video and interviews with older relatives who lived during segregation. Challenge students who are adept researchers with finding the answer to a difficult question.

Reading material on the Web sites and in the Harcourt/Brace fourth grade anthology biographies is too easy or too difficult.	Offer students a broader range of research materials representing a broader range of reading levels.
Difficulty maintaining focus, attention, and involvement during the class-wide PowerPoint presentation and discussion.	Offer students the chance to view the PowerPoint presentation a second time by themselves or in pairs at a computer. Present the PowerPoint to smaller groups of students at a time.

Recommendations for Implementation at the Classroom Level

Although UDL web-based applications and software programs exist, they are not pervasive. 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 an approach 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, has 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, www.k8accesscenter.org 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 digital of 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. 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, Kurzweil 3000, 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. 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 the available technology support. This may come in the form of a school or district IT center or help desk, 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. 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 to 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 Universal Design for Learning 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 (See Figure 6).

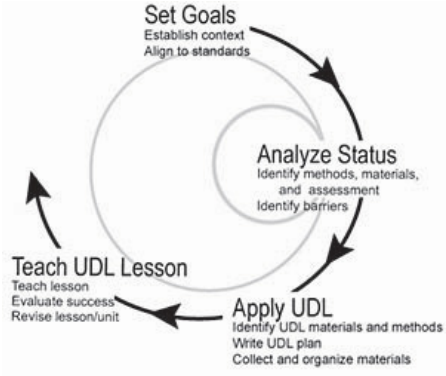

Figure 6.
The 4-step UDL lesson-design process.

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 assure alignment and assure 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 when selecting new texts, teachers use only those textbooks that have a digitized version accompanying the book. Teachers and students have text-to-speech readers available 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 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, 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

For students to succeed throughout the curriculum they must develop appropriate background knowledge and the ability to use it. Research studies show that helping students to build and activate background knowledge significantly improves their comprehension of expository texts, thereby facilitating content-area learning. Effective instructional approaches include direct instruction of background knowledge and instruction to reflect on and record prior knowledge. These approaches have the added advantage of directly supporting UDL and students' diverse abilities and preferences for recognizing patterns. In this way, they can help minimize barriers to content area learning and optimize every student's chance to succeed. The ideas and examples shared in this article can help educators to capitalize on the mutually supportive relationship between background knowledge instruction and UDL, and better ensure that every student is a literacy success.

Resources on the Internet

General Background Knowledge

North Central Regional Educational Laboratory—Critical Issue: Building on Prior Knowledge and Meaningful Student Contexts/Cultures
http://www.ncrel.org/sdrs/areas/issues/students/learning/lr100.htm

This Web site illustrates how teachers can more effectively support students' learning through building and activating prior knowledge. This site houses information about instructional issues, goals, and methods related to the use of students' prior knowledge in classroom. This site also provides a series of links to sites with definitions of key terms and ideas suggested by experts in the field. Three cases are provided as successful models.

U.S. Department of Education—Teaching Our Youngest: A Guide for Preschool Teachers & Child Care & Family Providers. Building Children's Background Knowledge and Thinking Skills
http://www.ed.gov/teachers/how/early/teachingouryoungest/index.html
This Web site provides an instructional guide for caregivers and teachers to help develop young children's background knowledge and thinking skills. This site proposes concrete ideas to enrich and expand children's knowledge building through the uses of various educational resources, such as books, discourse, classroom guests, and filed trips. The PDF version of this guide is available through: http://www.ed.gov/teachers/how/early/teachingouryoungest/page_pg11.html

Queensland Government—The New Basics Project/Productive Pedagogies: Background Knowledge
http://education.qld.gov.au/corporate/newbasics/html/pedagogies/connect/con2a.html

The New Basics Project takes place in Queensland, Australia, and aims to improve students' learning outcomes through dealing with students' identities, new economies and workplaces, new technologies, diverse communities and complex cultures. This Web site illustrates instructional practices with different degrees of connectedness between students' linguistic, cultural, world knowledge and experience and the topics, skills and competencies in lessons. This site provides definitions of high-connected and low-connected instructional practices, the continuum to describe different degrees of connectedness, and an example of a high-connected instruction in a grade 6 classroom.

Background Knowledge and Technology

Joseph, Linda C. (2002). Multimedia School, Cyberbee: Building Prior Knowledge
http://www.infotoday.com/MMSchools/may02/cybe0502.htm

This Web site contains an example of successful classroom instruction which incorporated multimedia technology into every aspect of the lesson in order to foster the students' use of their background knowledge and overall learning. This site describes the social studies instruction conducted by a fourth grade classroom teacher who used the multimedia technology, such as Microsoft Word/Digital Photographs, PowerPoint, Web site, and Microsoft Publisher in order to activate and build students background knowledge. The lesson plan is provided with other resources and links regarding the topic, Jackie Robinson.

Background Knowledge and Reading

Farrell, Jack—What Exactly is "Prior Knowledge"?
http://www.readfirst.net/prior.htm

This Web site contains an article written by Jack Farrell, who is an English teacher at Newbury Park High School in California (His home page is http://www.readfirst.net.). In this article, Farrell explains the role of prior knowledge in learning and pervasive misconceptions that students should not be exposed to new concepts unless they have some prior knowledge of the topic. Read First is an instruction method through which the students read silently and independently before others, including their teachers, control their thinking processes. Ferrell describes how Read First is aligned to California Reading standards for middle school age students.

DiGiacomo, Susan—Reading Instruction Handbook: Activating Personal Knowledge
http://curry.edschool.virginia.edu/go/edis771/webquest2000/student/ssusandigiac/priorknowldge.htm

This Web site provides information of using students' prior knowledge as one of the reading comprehension strategies. Susan DiGiacomo emphasizes student's realization of the importance of their prior knowledge to their reading processes and provides some instructional techniques that teachers can employ in order to activate students' prior knowledge, including pre-reading activities. This site is linked to a Web site with more information of various reading comprehension strategies and to DiGiacomo's home page at: http://curry.edschool.virginia.edu/go/edis771/webquest2000/student/ssusandigiac/home.html.

TLL (The Library Lady) Education Services—Building a Network of Prior Knowledge
http://www.thelibrarylady.net/Literacy%20Education/emergent_reader.htm

The focus of TLL Education Services is to assist educators and parents of emergent readers to initiate the development of teaching methods and new curriculum. This Web site highlights the importance of prior knowledge to child's reading development based on the notion of neural reorganization and restructuring of new information. This sites also provides some ideas of shortening child's assimilation period through using activities which build a network of prior knowledge, such as introducing the subject topics prior to actual instructions and connecting the subject topics to child's personal lives.

Christen, William. L. & Murphy, Thomas. J. (1991). Increasing Comprehension by Activating Prior Knowledge. ERIC Clearinghouse on Reading, English, and Communication
http://www.ericdigests.org/pre-9219/prior.htm

The authors reports three major topics of research: "(1) building readers' background knowledge; (2) activating readers' existing background knowledge and attention focusing BEFORE reading; and (3) guiding readers DURING reading and providing review AFTER reading". The authors also suggested three major instructional interventions for students who have little prior knowledge: "(1) teach vocabulary as a pre-reading step; (2) provide experiences; and (3) introduce a conceptual framework that will enable students to build appropriate background for themselves" as well as classroom implications based on teachers' understandings of the levels of students' prior knowledge.

Bank State College of Education—Literacy Guide: Making Connection between New and Known Information
http://www.bankstreet.edu/literacyguide/back.html
This Web site provides information of effective literacy teaching, which builds students' learning of new concepts on their diverse areas of existing knowledge of language, world, and how the system of prints works. The sites supports the concept that activating prior knowledge before reading is an important step to foster comprehension for both experienced and beginner readers.

Intervention Central—Prior Knowledge: Activating the 'Known'
http://www.interventioncentral.org/htmdocs/interventions/rdngcompr/priorknow.php
This Web site provides information on how to use text prediction strategies in order to activate students' prior knowledge and to increase their levels of reading comprehension. The information includes materials, preparation, and a step-by-step explanation of the procedure when the text prediction strategy interventions are implemented in classroom.

Lewin, Larry. (2003). Practical Ideas for Improving Instruction: Connecting to Prior Knowledge
http://www.larrylewin.com/

Larry Lewin, an educational consultant, explains that tapping in students' prior knowledge is one of the reading comprehension strategies and that students need assistance to use this strategy successfully. This site provides teachers a template of "open mind" to brainstorm their students' prior knowledge before reading.

Wilkes, Glenda—How Prior Knowledge Impacts New Learning
http://www.utc.arizona.edu/resources/thinkingseries/vol2_5.html

This Web site is a part of the site created by University Teaching Center at the University of Arizona. Wilkes explains that college students' prior knowledge often interfere with their accurate learning of new concepts due to their misconceptions and learning strategies. Wilkes states Ross's categorization of five possible text-related learning strategies used by college students and suggests that identification of students' prior knowledge is an important step for teachers to find out misconceptions and to avoid the negative impact of prior knowledge to new learning.

Houghton Mifflin Education Place—Learner Variables to Consider in Meeting Individual Needs: Prior Knowledge
http://www.eduplace.com/rdg/res/literacy/meet1.html
This Web site contains a short explanation of use of prior knowledge as one of the important variables which affect students' learning. Other variables introduced in this site include language and cultural background, rate of learning, amount of instructional time, and interests and attitudes. The site provides a suggestion that prior knowledge is a key for literacy learning and constructing meaning for all students.

Coiro, Julie. (2000). Literacy Information and Technology in Education—Qualitative Reading Inventory: Assessment of Prior Knowledge
http://www.lite.iwarp.com/qriprior.htm
Coiro introduces a reading inventory to assess students' familiarity/prior knowledge to the topics of reading and to activate students' prior knowledge. This Web site includes descriptions of this inventory in terms of preparation, purpose, procedures, scoring, and a guide to analyze the results. This inventory has two sections of tasks, namely conceptual questions tasks and prediction tasks.

Background Knowledge and Science Instruction

Roschelle, Jeremy. (1995). Learning in Interactive Environments: Prior Knowledge and New Experience
http://www.exploratorium.edu/IFI/resources/museumeducation/priorknowledge.html
The focus of this article is on developing new perspectives of the roles of prior knowledge in learning. Considering the paradoxical views of prior knowledge (prior knowledge as an important element for constructive learning process and prior knowledge as a conflicting element to learning process), Roschelle reviews research findings, major theories, and empirical instructional methods and provides scientific interpretations of learning, major perspectives on the process of learning as conceptual change, and successful learning experiences that foster learners' reasoning skills. This site is a part of the Museum Education website developed by Institute of Inquiry, which focuses on inquiry-based science instruction.

Biology Lessons for Prospective and Practicing Teachers—Instructional Philosophy: Prior Knowledge
http://www.biologylessons.sdsu.edu/philosophy/prior.html
This Web site is designed for prospective and practicing elementary school teachers to improve their teaching in science and biology. This site provides four philosophical lessons for teachers (1) to elicit students' prior knowledge as a starting point, (2) to present familiar topics, (3) identify student's prior knowledge, and (4) identify students' alternative conceptions which may impede their learning new concepts.

Jason Project Online—Learning Analysis: Background Knowledge
http://www.stanford.edu/~btobin/courses/106/jason_online/design_review_site/pages/learning_analysis/features_details.htm#background
Jason project proposes a multimedia and interdisciplinary approach to improve teaching and learning science. This Web site introduces the uses of digital labs (multimedia game) and video as possible instructional tools to build students' background knowledge in science.

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