

Analogical Processes and College Developmental Reading

By Eric J. Paulson

ABSTRACT: *Although a solid body of research concerning the role of analogies in reading processes has emerged at a variety of age groups and reading proficiencies, few of those studies have focused on analogy use by readers enrolled in college developmental reading courses. The current study explores whether 232 students enrolled in mandatory (by placement test) developmental reading courses in a postsecondary educational context utilize analogical processes while engaged in specific reading activities. This is explored through two separate investigations that focus on two different ends of the reading spectrum: the word-decoding level and the overall text-comprehension level. The two investigations reported here build on comparable studies of analogy use with proficient readers. Results indicate clear use of analogy at the decoding level of reading with trends toward some types of analogy use facilitating comprehension at whole-text levels of reading.*

Analogy appears to be a key element of human thinking.

Developmental reading courses are typically designed to increase the reading proficiency of college students who are underprepared for college-level reading. Existing at U.S. higher education institutions since the beginning of the 20th century (Kingston, 2003), developmental reading has historically been a core part of developmental education offerings in two- and four-year colleges (Stahl & King, 2009). Reading difficulties have been judged to be “the most serious” developmental proficiency issue (Adelman, 2004, p. 87) for college students. With recent analyses of ACT college entrance test scores indicating that fewer than half of incoming college students nation-wide were prepared for the reading requirements of a typical first-year college course (ACT, 2013), developmental reading support at the postsecondary level is prevalent and an important part of a college education for a significant number of students. Research that allows for a fuller understanding of developmental reading processes, with implications for instruction, is important. This study investigates the role of analogical processing during the reading process for students who place into developmental reading courses.

Analogical Processes

In a general educational sense, one key process by which people make sense of new information

is analogical. An analogical process involves the identification of partial similarities between different objects or situations to support further inferences and is used to explain new concepts, solve problems, and understand new areas and ideas (Gentner, & Colhoun, 2010; Gentner & Smith, 2012). For example, when a biology teacher relates the functions of a cell to the activities in a factory in order to introduce and explain the cell to students, this is an analogical process designed to use what is already familiar to illuminate and explain a new concept. A process of mapping similarities between a source (what is known) and a target (what is needed to be known) in order to better understand the target (Holyoak & Thagard, 1997), analogies are commonly used to make sense of new information in general. Scholars in cognitive psychology have argued that many aspects of thinking are analogical in nature, with some concluding that analogical processes form a core aspect of human cognition (e.g., Hofstader, 2001; Kurtz, Miao, & Gentner, 2001). Supporting this view of the integral nature of analogy to cognition is its use by even very young children. Holyoak and Thagard (1995) report that infants are able to use basic analogical processes, and by the time children are 5 or 6 years old, they are able to use complex analogies for many purposes. In short, analogy appears to be a key element of human thinking.

Reading is a sociocognitive process of making sense of information presented through text, and difficulties in reading can be intensified when the text involves unfamiliar content and new words. Because of the core nature of analogy in human learning, its role in a sociocognitive process like reading warrants exploration. This article investigates analogical processes in reading, at a basic word decoding level and at a higher, whole-text comprehension level.

Research on Analogical Processes and Reading

From a theoretical standpoint, analogy use in reading can be directly related to schema-theoretic explanations for reading comprehension. Hofstader (2001, p. 504) described any “triggering of prior mental categories by some kind of input—whether sensory or more abstract” as a process of analogy

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construction. Schemata are those “mental categories”—as well as concepts and structures—that help us make sense of the world. Schema theory notes that new information is processed through interaction with old information, resulting in what is known as comprehension (Anderson & Pearson, 1984). Specific to reading, this means that a reader’s ability to comprehend a text is directly related to the reader having the appropriate schemata (see Anderson, 2013; Faris & Smeltzer, 1997). Reading involves a constant, albeit many times implicit and nondeliberate, comparison of the new information in the text to what the reader already knows about the topic of the text in order to make sense of what is being read. This is an analogical process. Because reading is not a monolithic entity, this article addresses analogical processing in reading in terms of more than a single measure of reading. Specifically, a focus on decoding words and on more holistic comprehension of whole texts are both included.

Experienced Readers’ Use of Analogy to Decode Words

Using analogical processes to assimilate and accommodate new information during reading is an important aspect of reading at a variety of early reading levels (e.g., Farrington-Flint & Wood, 2007; Goswami, 2013; Wang & Gaffney, 1998). The use of analogical processes appears to be an important aspect of more experienced and proficient reading as well, though research at this higher level is not nearly as widespread as research at the emergent-reading level.

Kay and Marcel’s (1981) early research demonstrated how older readers’ reading of nonsense words that had multiple acceptable pronunciations was affected by the real words that immediately preceded the nonsense word. For example, when presented with a list of words, readers were likely

to read the nonsense word “yead” as /yEd/ (rhymes with “bed”) if preceded by the real word “head” and more likely to pronounce it /yid/ (rhymes with “seed”) if preceded by the real word “bead.” Similarly, Marsh, Desberg, and Cooper (1977), who established some influential approaches to investigating analogy (Nunes, Bryant, & Barros, 2012), looked at analogy use in 5th grade, 11th grade, and proficient college-level participants reading lists of unfamiliar words (unfamiliar words as used in this article are new, unknown words constructed for the study). The purpose of the study centered around understanding the type of reading strategy employed by readers at each level. Specifically, the two approaches the researchers considered were a “grapheme-phoneme correspondence” strategy—essentially applying a letter-sound phonics rule—and an “analogy strategy,” which consisted

of relating the new word to a known word in order to read aloud the new word. For example, reading the unfamiliar word “tepherd” by a letter-sound rule application would result in /teferd/, where the “ph” digraph would be pronounced /f/ as in “phone.” Alternatively, reading “tepherd” by analogy strategy would result in /teperd/ by analogy to the known word “shepherd.” Marsh et al. (1977) reported that when knowledge of the analog source was accounted for—that is, in order to use the word “shepherd” as an analog to read the unfamiliar word “tepherd,” the reader would have to know the word “shepherd”—they found that the 5th grade group used an analogy strategy 39.5% of the time, the 11th grade group used an analogy strategy 41.12% of the time, and the college group used an analogy strategy 56% of the time.

Experienced Readers’ Use of Analogy in Whole-Text Reading

Clement and Yanowitz (2003) investigated reading processes at a more holistic, whole-text level and

Verbally producing a word accurately does not necessarily imply comprehension of that word.

found that college students were able to analogically relate the information in a source text to that of an unfamiliar, target text in order to problem-solve in the target text. That is, where the source text explicitly modeled a solution to a problem in one arena, readers were able to use that text to better understand the target text in another arena. Bean, Searles, and Cowen (1990) also investigated analogy use at the whole-text comprehension level with a study designed to “explore the impact of text-based analogies on students’ comprehension of a high school biology text passage” (p. 324). One hundred and nine students were randomly assigned to either the control condition or the experimental condition group. The control condition was a two-paragraph passage from a biology textbook about how enzymes control the rate of chemical reactions. The experimental condition was the same passage with an analogy to a “lock and key” embedded in the passage. After reading either the experimental text or the control text, students responded to a short-answer quiz on the reading, and their answers were evaluated for the presence of major ideas and supporting details. The results of the quiz indicated a trend toward the analogy version promoting reading comprehension, though the results were not statistically significant.

Hammadou (2000) took a similar approach in examining analogy use during reading, looking at reading in a second language as well as first language in college students (the first-language aspects of her study are of interest here). Four passages were used with two versions each. Students read either a baseline text or a version of that text with an analogy embedded within it, similar to the approach taken by Bean et al. (1990). Students read the version they were assigned, then wrote everything they could recall from the passage on a separate sheet of paper. The written recalls were scored using Meyer’s (1985) idea-units analysis protocol. Results indicated a trend toward better recall of the nonanalogy versions of the text; for one pair of analogy/no-analogy versions, it was a nonstatistically significant trend and for the other pair of text versions there was a statistically significant difference of better comprehension on the no-analogy version.

Purpose of the Current Study

Despite the amount of attention that the role of analogies in reading processes has received at a variety of age groups and reading proficiencies, there has been little research that focuses on analogy use by students enrolled in developmental reading classes at the postsecondary level. As such, of interest here is whether—and if so, how—readers at this level utilize analogical processes during reading.

As noted, two “levels” of reading processes have been focused on in studies that have investigated analogical processes. One level is described here as the “decoding” level. At this level, readers utilize knowledge of sound-symbol correspondence to verbally produce combinations of letters according to accepted convention, which can be thought of as “reading a word aloud.” Although a general indicator of comprehension and correlate of reading ability, verbally producing a word accurately does not necessarily imply comprehension of that word or its use. Nevertheless, decoding is an important aspect of overall reading processes.

Another level of reading processes that has been investigated in studies of analogical processes is that of holistic understanding of a text. At this level, what is measured is not accurate oral production of text but rather some aspect of comprehension on a whole-text level. This is a somewhat more difficult level of reading to accurately and reliably measure than that of decoding, which may partially explain the relative dearth of analogy-focused research at the whole-text comprehension level compared to the word-decoding level.

Both the decoding level and the whole-text comprehension level are important aspects of reading processes, both have been investigated from an analogical-process perspective, and both will be considered in this study when considering the

reading processes of students placed into developmental reading courses at the postsecondary level. This article focuses on analogy use during reading by college students enrolled in several sections of a mandatory (by placement test) developmental reading class, and it explores two aspects of reading processes: the use of analogy to read and decode unfamiliar words and analogy use at the whole-text comprehension level.

Investigation One

Investigation One focuses on analogy use at the decoding level of reading processes that deals with reading unfamiliar words. There is relatively consistent evidence for analogy being used at the decoding level of reading by young children; emerging readers are able to name an unfamiliar word based on knowledge of a similar graphic or phonological element of a known word (e.g., Goswami, 2013; Wang & Gaffney, 1998; White, 2005). In addition, the early and limited studies that have been undertaken of analogy processes at the decoding level of reading in older, experienced readers show similar usefulness of an analogical process (e.g., Kay & Marcel, 1981; Marsh et al., 1977). This investigation adopts some of the materials used in the Marsh et al. (1977) study because of the pioneering nature of that work (Nunes, Bryant, & Barros, 2012).

There are several focal questions for this investigation. The first is: Do developmental college readers read unfamiliar words through a letter-sound correspondence process or an analogical process? The second question is: Is there a difference in analogy use at this level between words presented in a list and the same words presented in connected text? The third question pursued in this investigation has to do with the usefulness of analogy during the reading process in general. If analogy use is an important aspect of the reading process, as Goswami (2013) suggests, a crucial

part of analogy research must include information about how analogy use can be activated. So another question Investigation One pursues is: Does exposing participants to analogical source words before they read the unfamiliar words increase analogy use in developmental reading at the college level?

Method: Investigation One

Location. This investigation's educational context was a four-year comprehensive Midwestern college with an open-access unit providing developmental courses in reading, writing, mathematics, and communication as well as general "first-year experience" courses for college freshmen. All of the participants in this study were students enrolled in various sections of the same developmental reading course in the open-access unit. Enrollment in the developmental reading course was based on a combination of ACT or SAT scores and the Degrees of Reading Power test score incoming students took as a placement test. Enrollment was mandatory for students testing below a certain score.

Participants. Eighty students took part in Investigation One. Female students comprised 51.1% of the sample, and .4% of the students were Hispanic, .8% were American Indian, 2.3% were Asian/Pacific Islander, 31.7% were White non-Hispanic, 60.7% were Black non-Hispanic, and 4.2% were Other/Unknown. Their average high school GPA was 2.34, average ACT score was 15.1, and average SAT score was 770.5. The average age was 19.4 and the average raw score on the Degrees of Reading Power placement test was 43.1 out of 70.

Materials. The materials in this first investigation consisted of the 10 unfamiliar words and 10 analog source words used in the Marsh et al. (1977) study. However, in the current study, the words were presented in both list form and embedded within a paragraph of connected text. Descriptions of list and paragraph materials follow:

List material. In this condition, participants viewed unfamiliar words, each presented separately on a large note card.

Paragraph material. In this condition, participants read the first paragraph of *A Clockwork Orange*, the 1962 book by Anthony Burgess, with the unfamiliar words embedded within the paragraph. *A Clockwork Orange* was chosen as a source text within which the unfamiliar words would be embedded because of the nature of the book as one in which the author consistently used invented nonsense words as part of the characters' dialect throughout the story. Of the 11 nonsense words in the first paragraph of the story, 10 of those were replaced with the unfamiliar words used in this investigation. Replacing the nonsense words in the original story with the unfamiliar words for this study was done in order to replicate an authentic reading experience, specifically the experience readers have when beginning *A Clockwork Orange*. That is, instead of creating a fake paragraph in which to embed the unfamiliar words used in this study, this approach instead replicated that of an actual work of fiction. Although the text used in this study is artificial, it appears very much like the *A Clockwork Orange* text does the first time that text is read: a mix of traditional, known vocabulary and syntax with artificial words. None of the participants in the paragraph groups (see Table 1) had previously read, or were familiar with, *A Clockwork Orange*.

Procedures. Participants in Investigation One were randomly assigned to one of four groups, as noted in Table 1. All groups used the same 10 unfamiliar words and analog source words. Groups 1 and 3 read them in list form, and Groups 2 and 4 read them embedded in connected text. Groups 1 and 2 read the analog source words *after* the unfamiliar words to confirm that they knew the words needed to use an analogy strategy. Groups 3 and 4 read the analog source words *before* reading the unfamiliar word materials. Group treatment variation was designed to measure the effect of prereading exposure to analog source words on analogy use: whether presenting readers with analogical source words before reading the unfamiliar words would activate analogy use when readers encountered an unfamiliar word. For example, this question involved whether reading the analog source word "shepherd" before reading the unfamiliar word "tepherd" would result in greater use of an analogical process when reading "tepherd" (see Table 2 for more information about the processes). Directions associated with the prereading conditions were restricted to participants in these groups being told that "there may be some similarities between the real words in the list and the unfamiliar words" they would read. In all groups, each part of the task was completed before the next part was begun; for

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Table 1
Four Intervention Groups, Investigation One

Group Titles	Group Descriptions
Group 1: List version	This group read aloud the list of unfamiliar words, then read aloud the analog source words to confirm that they knew the words needed to use an analogy strategy.
Group 2: Paragraph version	This group read aloud the modified <i>A Clockwork Orange</i> text with the unfamiliar words embedded, then read aloud the analog source words to confirm that they knew the words needed to use an analogy strategy.
Group 3: Prereading list version	This group read aloud the analog source words first, then read the list of unfamiliar words.
Group 4: Prereading paragraph version	This group read aloud the analog source words first, then read the modified <i>A Clockwork Orange</i> text with the unfamiliar words embedded.

example, a participant in Group 4 would read the entire list of the 10 analog source words before reading the paragraph with the unfamiliar words embedded.

Analysis

When reading aloud an unfamiliar word, it is possible to read the unfamiliar word from what could be attributed to an analogical process or some process other than analogy (e.g., letter-sound rule application). That is, an unfamiliar word could be read aloud in a way that uses the reader's knowledge of a similar looking word as an analogy—termed the analog source word—in order to read the unfamiliar word. Or, an unfamiliar word could be read aloud through the application of a phonics rule (e.g., the digraph “ph” makes the /f/ sound). Depending on the method used to read aloud the unfamiliar word, there could be more than one pronunciation produced (see Table 2).

Thus, a word was scored as being read through an analogical process if it shared a phonological rime with a known word (a rime is the sound in a word that follows the initial consonant sound, which is called the onset; in the word “kite” the onset is /k/ and the rime is /ite/). This assumption about a strong link between analogy processes and rhyming is supported by research into onset-rime and rhyming analogies in young readers (Goswami, 1999, 2013). As noted in Table 1 (p. 4), participants were tested for knowledge of the analog source words. If a participant did not know the analog source word, the corresponding unfamiliar word was not considered during data analysis because

an analogical process would be less likely without familiarity with that analog source word.

Results

Within each group, there were varying levels of analogy use demonstrated (see Table 3). In groups one and two, an analogical process was utilized more frequently than a letter-sound correspondence process, but that difference was not statistically significant. In groups three and four, which both employed exposure to the analog source words before reading the unfamiliar words as part of the intervention, analogical processes were utilized statistically significantly more frequently than nonanalogical processes (Group Three: $t(19) = 8.11, p < .001$; Group Four: $t(19) = 4.68, p < .001$). In addition, a one-way analysis of variance revealed a significant difference between the four groups ($F(3, 76) = 7.812, p < .0001$). Fisher's Least Significant Difference (LSD) posthoc analysis compared analogy use between each group. The posthoc test revealed significant differences in four pairings, all of which indicated that raising readers' awareness of appropriate analogical source words before they read the unfamiliar words resulted in greater use of an analogical process than not providing readers with analogical source words prior to reading the unfamiliar words. No significant differences between list and paragraph conditions were found.

Discussion: Investigation One

The first question in Investigation One focuses on whether students placed in developmental reading courses read unfamiliar words through an analogical process or a nonanalogical (e.g., letter-sound correspondence) process. Although results reveal a tendency in all four conditions for analogical

processes to be used more frequently than non-analogical processes, only in the conditions which included exposure to analog source words prior to reading the unfamiliar words were the differences statistically significant. As is discussed in a subsequent section, priming readers by raising their awareness of analogical source words appears to stimulate the use of analogy as a reading process in both list form and paragraph form.

The second question in Investigation One involves the difference in analogy use between reading the words in a list and reading the words in paragraph form. An ANOVA has revealed a significant difference between the four groups ($F(3, 76) = 7.812, p < .0001$). Two comparisons inform this line of inquiry:

- Comparison A: Group 1, List version vs. Group 2, Paragraph version
- Comparison B: Group 3, Prereading list version vs. Group 4, Prereading paragraph version

Although analogical processes were used to a greater extent than nonanalogical processes in these two comparisons, the LSD posthoc analysis results demonstrate that the difference was not significant (see Table 4).

The third question associated with Investigation One examines whether raising readers' awareness of appropriate analog source words before reading the unfamiliar words increases analogy use. If analogies are important at all during the reading process, it is worthwhile to examine how to activate the use of analogies in readers. Within each type of material—list or paragraph—half of the participants read a list of the analog source words before reading the list or paragraph with the unfamiliar words. The participants were told that “there may be some similarities between these real words and the unfamiliar words you're about to read.” This priming was thus subtle in that the participants were not instructed to use analogies while reading but simply had the analog source words brought to their attention before reading

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Table 2
Example of Each Process When Reading tephherd

Description of Process	Example
Unfamiliar word: This is the word the participant would read aloud, which could be pronounced either through a letter-sound correspondence process or an analogical process.	tephherd
Analog word: This is the analog source word that the participant would be exposed to either before or after reading the unfamiliar word.	shepherd
Letter-sound correspondence process: If the participant read the unfamiliar word using this process, it would sound like this example.	The <i>ph</i> in “tephherd” pronounced like <i>f</i> (sounds like “teferd”)
Analogical process: If the participant read the unfamiliar word using this process, it would sound like this example.	The <i>ph</i> in “tephherd” pronounced like <i>p</i> (sounds like “teperd”)

Table 3
Percent Mean Analogy Use by Task

Group	N	M	SD
Group 1: List version	20	58.3	21.7
Group 2: Paragraph version	20	54.5	16.4
Group 3: Prereading list version	20	80.5	16.6
Group 4: Prereading paragraph version	20	70.2	19.3

the unfamiliar words. The comparisons to shed light on this question are:

- Comparison C: Group 1, List version vs. Group 3, Prereading list version
- Comparison D: Group 2, Paragraph version vs. Group 4, Prereading paragraph version

Fisher's LSD posthoc test has revealed a significant difference at the $p < .01$ level for both comparisons: The prereading groups used analogical processes significantly more often than the groups that were not exposed to the analog source words prior to reading the unfamiliar words. Priming appears to activate analogy use in these reading tasks for these developmental readers.

Summary: Investigation One

Investigation One explored reading at the word-decoding level, a foundational aspect of reading. Investigating how readers in a developmental reading course utilize analogical processes at that level of reading is useful in understanding the role of analogy in reading processes in general. Investigation Two focuses on what may be described as a different end of the spectrum of reading processes: overall comprehension at the text level. In addition, it follows up on the results of the first investigation.

Investigation Two

Investigation Two focuses on whether analogy use similar to what was found at the decoding level (Investigation One) is also demonstrated at more holistic levels of reading. In the research literature, there is much less consistency when considering whether analogies facilitate comprehension in higher levels of reading. For example, whereas Clement and Yanowitz (2003) and Vosniadou and Ortony (1983) have found a facilitating effect for the utilization of analogy, Giora (1993) and Hammadou (2000) have identified a debilitating effect of analogy usage, and Bean et al. (1990) found no significant difference in the students'

comprehension between texts that utilized analogies and texts that did not. This, of course, is the key area of interest in terms of analogical processes for students enrolled in developmental reading classes: whether analogy use facilitates comprehension, hinders comprehension, or has no effect at all.

Within that broad question, the type of analogy use that may or may not make an impact on reading comprehension is investigated. Specifically, the first question of Investigation Two focuses on the extent to which providing a useful analogy to readers immediately before reading the target text is useful: that is, whether exposing students to analogical information before reading the target text facilitates comprehension. The second question of Investigation Two focuses on whether exposing readers to an analogy embedded in the target text itself—as opposed to before they read the target text—is effective in promoting reading comprehension.

Method: Investigation Two

Location. The educational context for Investigation Two was the same as in Investigation One. Participation included different sections of the same developmental reading course in an open-access unit in a Midwestern college (see Method: Investigation One for details).

Participants. There were 152 participants that took part in Investigation Two. Female students comprised 55.8% of the sample, and 1.9% of the students were Hispanic, .4% were American Indian, 3.5% were Asian/Pacific Islander, 35.7% were White non-Hispanic, 51.6% were Black non-Hispanic, and 4.7% were Other/Unknown. Their average high school GPA was 2.62, average ACT score was 15.7, and average SAT score was 760.5. The average age was 19.1, and the average raw score on the Degrees of Reading Power placement test was 44.3 out of 70.

Materials. A required class assignment across sections in the developmental reading course from which the participants were drawn involved summary writing. Introductions to the

assignment “how to write a summary”—usually a part of coursework in the second or third week of the course—included a written text describing the assignment. During this window of time, with the permission of each course section's instructor and each student's written consent, the investigation materials were used in class to introduce that summary writing assignment. This arrangement allowed a high level of ecological validity to be incorporated into the study, since students' reading of a text they were assigned for a clearly defined purpose that already existed within their course requirements was analyzed. Three versions of this text were constructed to use as materials for this study, and these became the independent variables.

Version 1: No-analogy version. This version of the text is a straightforward description of the course summary writing assignment and serves as a baseline measure against which the two analogy versions of the text may be compared. Version 1 is very much like the default explanations of summary writing used by instructors of this course to introduce this assignment; in the absence of this project, instructors would be providing such a text to their students.

Version 2: Prereading analogy version. This version of the text is exactly like Version 1 (no-analogy version) except that it is preceded by a short text that exposes students to an analogy for summary writing. The analogy text is a brief description of going to a movie and then describing that movie to someone who hasn't seen it before, with the analogy to summary writing made explicit. This version of the text investigates the usefulness of priming students for analogy use before reading the target text.

Version 3: During-reading analogy version. This version of the text uses the same analogy as the prereading text in Version 2, but it is embedded within the body of Version 1. This version investigates the usefulness of the movie analogy (the analogy that was the core of the prereading analogy text in Version 2) embedded within the baseline text (the text from Version 1). At issue here is whether the reading process is facilitated by exposing readers to an explicit analogy embedded within the target text, as opposed to priming the analogy in advance, as in Version #2.

Procedures. Participants in Investigation Two were randomly assigned to one of three groups: No-analogy (Version 1), prereading analogy (Version 2), or during-reading analogy (Version 3). The instructions were the same for each group: “Read this paragraph about summary writing and when you're finished, turn it over. On the back, you'll write an answer to the request: ‘Based on what you just read, explain how to write a summary in your own words.’” The language of the

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Table 4

LSD Test Comparison of Analogy Use by Task

Group	LSD Posthoc Test
Group 1, list version vs. Group 2, paragraph version	nonsignificant
Group 1, list version vs. Group 3, prereading list version	$p < .01$
Group 1, list version vs. Group 4, prereading paragraph version	$p < .05$
Group 2, paragraph version vs. Group 3, prereading list version	$p < .01$
Group 2, paragraph version vs. Group 4, prereading paragraph version	$p < .01$
Group 3, prereading list version vs. Group 4, prereading paragraph version	nonsignificant

instructions was designed to elicit their understandings of the text without implying a word-by-word memorization task. If analogical processes are used at this whole-text comprehension level of reading, providing explicit analogical information should facilitate that analogy use and, therefore, facilitate comprehension.

Analysis

Participants' written recalls were analyzed in two ways. First, each written recall was evaluated in terms of propositions (Goldman & Wiley, 2011) and concept units (Meyer, 1985; Voss, Tyler, & Bisanz, 1982). Each recall was also holistically scored (Arter & McTighe, 2001; Kucer & Silva, 1999) for evidence of understanding overall themes, ideas, and purposes in the texts. Two doctoral graduate research assistants were trained in each analysis method and independently evaluated each participant's recall. The evaluators then compared analyses and consulted the principal investigator if there was a disagreement; interrater reliability was greater than 97% across all analyses. Both evaluation measures were then combined to produce a single comprehension measure for each participant which was then used for statistical analysis.

Results

Mean comprehension measures are displayed in Table 5. An ANOVA revealed a significant

Table 5
Percent Comprehension Measures for Each Version

Group	<i>M</i>	<i>SD</i>
Version 1: No analogy	57.75	12.82
Version 2: Prereading analogy	54.08	12.83
Version 3: During-reading analogy	59.83	13.80

Note. Percentages are of total possible evaluation points across both the concept unit and the holistic evaluation measures.

Table 6
LSD Test Comparison of Analogy Use by Task

Group	LSD Posthoc Test
Version 1, no analogy vs. Version 2, prereading analogy	nonsignificant
Version 1, no analogy vs. Version 3, during-reading analogy	nonsignificant
Version 2, prereading analogy vs. Version 3, during-reading analogy	$p < .05$

difference between the three conditions with alpha set at the .10 level but not the .05 level ($F(2, 149) = 2.467, p = .088$). Although .05 is more conservative and less apt to result in Type I errors, for a two-tailed exploratory study the .10 level is an acceptable level if for no other reason than to guard against Type II errors (see Ary, Jacobs, Sorensen, & Razavieh, 2009).

Fisher's LSD posthoc test revealed significant differences between Version 2: Prereading analogy and Version 3: During-reading analogy (see Table 6). These results indicate a difference in the effectiveness of different types of analogical priming: raising readers' awareness of analogical relationships before reading the target text is not as effective as including analogical information in the target text itself.

Discussion: Investigation Two

There are two main issues tested in Investigation Two. The first is whether there was evidence of analogies playing a role in facilitating reading processes at the level of overall comprehension. The second is, if so, whether raising students awareness of analogical relationships before they read the target text or while they read the target text was more effective.

Study data reveal statistically significant difference between comparisons of the prereading analogy group and the during-reading analogy group but not between either of those analogy groups and the nonanalogy group. There are interesting tendencies within the data that bear mention.

First, the direction of the comprehension scores between the no-analogy text and the during-reading analogy text mirrors that of Bean et al. (1990): Both studies have shown nonsignificant tendencies for during-reading analogies facilitating reading comprehension over a nonanalogy condition. This may indicate that incorporating analogies into text may be a useful way of utilizing normal cognitive analogical processes, if the conditions are appropriate. This line of reasoning is discussed further in the general discussion section of this article.

Second, the version of the text that utilized a prereading analogy—priming students to think of a specific analogy *before* reading the no-analogy version of the text—had a negative tendency. That

is, comprehension scores were lower in this version than in the no analogy, baseline version. On the surface, that is an indication that analogy processes are not useful during reading, and may even be counterproductive. However, when considered in light of the positive tendency of the during-reading analogy comprehension measure in this project, what may be more accurate is that how analogies are presented in a reading situation is extremely important. That is, priming readers' awareness of analogical relationships by embedding analogies within the target text produced greater comprehension and assignment fidelity descriptions than providing a prereading analogical trigger.

Summary: Investigation Two

In sum, the primary purpose of Investigation Two centered around how readers enrolled in a developmental reading class utilized analogy during reading. The results demonstrated trends in two directions: (a) a nonstatistically significant tendency for a during-reading analogy to facilitate comprehension as opposed to not using an analogy and (b) a significant finding for a specific type of analogy presentation—embedding analogies within the target text itself—to facilitate understanding.

Discussion

This study explored analogy use during reading by students enrolled in a college developmental reading class by focusing on two ends of the reading spectrum: decoding unfamiliar words and overall text comprehension. Investigation One found a statistically significant effect for analogy use at the decoding level, which is appropriate since the literature is consistent on this point, across a variety of ages (e.g., Farrington-Flint & Wood, 2007; Goswami, 2013; Marsh et al. 1977). The finding here suggests that, like readers in k-12 contexts, analogical processes are frequently used by readers in a college developmental reading course as part of the reading process at the decoding level, especially when readers are exposed to analog source words prior to reading the unfamiliar words.

In contrast to the consistency in findings of analogy use at the decoding level, there is inconsistency in analogy use at the whole-text comprehension level, as Investigation Two revealed. There were significant differences between the three interventions in the current study—no-analogy, prereading analogy, and during-reading analogy texts—in Investigation Two. The direction of the tendency for the prereading analogy group was toward analogy hindering comprehension, and the direction of the tendency for the during-reading analogy group was toward analogy facilitating comprehension.

In Investigation One, participants utilized analogy more frequently than letter-sound correspondence rules in both the list groups and the

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Pedagogical Implications

paragraph groups. Analogy use was more prevalent when participants read the unfamiliar words in a list compared with when participants read the unfamiliar words in connected text, though this difference was not significant.

In one sense, this trend toward more analogy use with the words in a simple list may seem counterintuitive if analogy use is considered an important aspect of reading processes. However, in terms of syntactic information especially, a simple list of words is impoverished relative to connected text because readers have fewer cue systems (e.g., syntactic, semantic, pragmatic; see Goodman & Goodman, 2013) at their disposal to use while reading. If a list has fewer cue systems available to readers than does connected text, reading words in a list may require readers to utilize more basic word-recognition processes, including applying knowledge of letter-sound correspondence rules, or, in this case, using an analogical approach. When reading the simple lists, with no syntactic or semantic information with which to disambiguate the unfamiliar word, results indicate that readers tended to utilize analogy over sound-symbol correspondence rules. This implies that even in the most context-reduced environment—reading a list of unfamiliar words—readers are more likely to relate the unfamiliar word to a known word via an analogical route than they are to break the words down into phonemes and reproduce the words via sound-symbol correspondence rules. That is, at this decoding level of reading, readers appear to efficaciously link new information to known information analogically while reading to make sense of the new information.

The prevalence of analogy use as being more pronounced in the reduced-context list in Investigation One may inform the understanding of results of Investigation Two, which focused on analogy use at the level of whole-text comprehension. When entire texts are the unit of meaning, the rich context and opportunities for varied cue use during reading are multiplied. This means that readers have recourse to many different aspects of reading processes while constructing meaning with the text, so any one aspect of the reading process will not be as prominent. Thus, in Investigation Two—with a focus on overall text comprehension—data show trends toward embedded analogies facilitating reading processes, as well as tendencies showing a lack of analogy as a useful aspect of the reading process when used as a prereading prompt in a text. These findings suggest that it is not simply the presence or absence of analogy relative to a text that facilitates the use of analogy during reading, but rather that the manner in which that analogy is presented affects whether and how analogy can play a role during reading.

An awareness that analogical processes play a role in even basic aspects of the reading process informs practitioners' understanding that tapping into analogical processes during reading may be useful in general. As discussed previously, there are solid theoretical links between analogy and schema theory. Some of the results of the investigations reported in this article demonstrate the utility of analogy as a powerful tool to access and use readers' existing schemata while reading.

The results of Investigation One do not form a lesson plan. But the results add to an understanding of processes that students have at their disposal and that they utilize during reading. The more that is understood about the processes involved when students confront unfamiliar aspects of text, the more tools instructors have to plan instruction in a way that taps into those processes. For example, emphasizing students' abilities to make connections between what they discover in the

This trend toward more analogy use with the words in a simple list may seem counterintuitive.

text and their own background knowledge—their schemata—is supported by these results.

The results of Investigation Two show possibilities for embedded analogies facilitating more comprehensive levels of reading. Extrapolating from these results, instructors should encourage students to watch for analogies that are presented in texts since, in this study, those analogies proved useful to students. For texts in which analogies are not present, instructors may want to encourage students to construct their own analogies as they read. This suggestion connects to evidence in the field that speaks to the value of student-generated elaborations during reading (Simpson & Nist, 2000). Because there is evidence for students' own text-based elaborations benefitting their comprehension levels, and this study has provided evidence for embedded analogies also benefitting reading, it is likely that asking students to generate analogies during reading can similarly support reading comprehension. Future research should address construction of analogies by students themselves, as comprehension aids.

More generally, an important question centers on how to best activate analogy use in college developmental readers at the whole-text level of comprehension. Like many other aspects of best practices in teaching developmental reading at the college level, there may be a metacognitive aspect to

tapping into analogy use, one that was not explicitly explored in the current study. Actively discussing the use of analogy with students—helping students become metacognitively aware of their own analogy use—may be a useful next step in researching these issues. Using metaphors—which, in their most basic form, are expressions of some types of analogical connections—to approach such discussions may be useful. Students' exploration of reading processes through an analysis of their own metaphors about reading and writing have been demonstrated to promote a greater understanding of active literacy processes and critical thinking (Paulson & Armstrong, 2011).


Conclusion

This study supports the idea that readers in college developmental reading courses clearly use analogy during basic reading processes like decoding unfamiliar words. This is an indication that these readers will use analogy during reading within certain parameters. At the whole-text comprehension level there were nonstatistically significant tendencies demonstrating that certain types of analogy presentation may engender connection to natural sociocognitive processes of analogy and facilitate comprehension, and other types of analogy presentation may not facilitate comprehension. These results indicate that further investigation into the relationship between analogical processes and reading processes may be worthwhile.

In short, analogy is a process, but one that lends itself to pedagogy fairly intuitively. Raising analogical processes to a metacognitive level makes explicit the connections students can, and should, make to their own knowledge and experiences. Using analogy explicitly with students to bring to the forefront their implicit knowledge about text and content while reading may be a productive approach to increasing students' control over their own reading processes. In this way, analogy can be an effective bridge to schema activation.

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