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Using Literature to Teach Inference across the Curriculum

"Inference is a statement about the unknown made on the basis of the known."
—Hayakawa, 1939

More than 70 years ago, S. I. Hayakawa, noted linguist, teacher, and statesman, recognized the power and potential of inference. Today, increasing numbers of teachers at all grade levels are doing the same.

They are recognizing that inference is a powerful way of thinking and an important 21st century skill for all students to use and develop across the curriculum. One sixth-grade teacher and her students experienced it for themselves. She stated:

> At the beginning of the year, I taught *Tiger Rising* (2002) by Kate DiCamillo. It is a wonderful book to teach inference. There is a symbol of a suitcase in that book. Students totally grasped the idea of a suitcase and its relationship to inference. Every character in the book has a suitcase and that is how you learn about the character—through that character's suitcase. And all people have a suitcase in real life. It was a very powerful symbol for my sixth-graders and an overarching theme for the year. I didn't plan it. My students just took the symbol and made it their own.

In addition to inference, increasing numbers of teachers are also recognizing that developing and implementing integrative curriculum is important at all grade levels, especially in middle grades education. It is one of seven design elements found in *Turning Points 2000* (Jackson & Davis, 2000) and a core characteristic of successful middle schools in *This We Believe* (National Middle School Association, 2003) and *Research & Resources in Support of This We Believe* (Anfara et al., 2003). Using literature to teach inference across the curriculum is an effective way to implement this design element.

This article shares literature and strategies to teach inference across the curriculum in middle grades education (grades 5–8). We begin with background on inference and then share literature and strategies to teach inference in science, social studies, mathematics, and language arts.

Background on Inference

Inference is a popular but nebulous term. This is due in large part to the fact that inference has been defined in many different ways. Among others, it has been defined as making predictions, drawing conclusions, using context clues, activating background knowledge, filling gaps, creating interpretations, visualizing meaning, and dealing with ambiguity. These definitions share two important understandings about inference—namely, that it is "the heart of meaning construction for learners of all ages" (Anderson & Pearson, 1984, p. 107), and it involves the ability to read between the lines (Harvey & Goudvis, 2007).

Inference can be understood on multiple levels. At one level, it can be viewed as an inherent, natural thinking process that individuals use to pose and solve problems. Specifically, it is a constructive thinking process by which individuals continually create and evaluate competing hypotheses in an attempt to progressively refine their thinking and understanding in order to ultimately solve a problem (Phillips, 1988). This process occurs as meaning is continually created

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and reconstructed, and is based on the notion that "confirming and disconfirming leads to new inferences and new predictions" (Goodman, 1996, p. 114). From birth, humans constantly, routinely, and almost effortlessly make inferences.

At another level, inference can be viewed as an integral part of the reading process. It posits that readers must do more than just read words in a text. They must lift up the words and go beneath them (Keene & Zimmerman, 2007). In addition, readers must be active, curious, use background knowledge, and recognize text clues to make sense of text. Simply stated, readers must understand seen and unseen text (Tovani, 2000) or, as Gallagher (2004) stated, "[R]eaders must see and consider things that are literally not on the printed page" (p. 80).

Inference is not uninformed guessing. The distinction is important. Guessing does not necessarily require supporting textual evidence, but inference does. It requires that "readers merge their background knowledge with clues in the text to come up with an idea that isn't written down in the text . . . . readers base their inferences on text evidence—that's what makes inferring different from guessing" (Harvey & Goudvis, 2005, p. 1). Moreover, "inferences are not random. While they may surface mysteriously with a sudden jump of recognition (a sense of 'Ah ha!'), inferences are very orderly. In short, inferences are informed guesses based on supporting evidence" (Kurland, 2000, p. 1).

Literature and Strategies

Literature is a powerful way to teach inference across the curriculum. Here, we provide picture-books (see Appendix A), young adult literature (see Appendix B) and instructional strategies to teach inference in science, social studies, mathematics, and language arts.

Inference in Science

"An inference is a hypothesis drawn from both previous knowledge and current cues, such as spoken words and sounds; written words and pictures; graphs and information; physical, emotional, and environmental prompts; and reactions of others. The person making the inference continues to gather information to test the correctness of the hypothesis. In short, it is thinking." (7th/8th-grade teacher)

Inference means readers go beyond surface understandings and delve deeper into meanings of text. In other words, they must know what text says and what text means. "What It Says, What It Means" is a strategy we used with *Uno's Garden* (Base, 2006) to integrate literacy and science (see Table 1).

Uno's Garden is an ecological account of what happens when humans occupy a natural area. Uno lives in a forest. More people join him.

> **Inference means readers go beyond surface understandings and delve deeper into meanings of text.**

Table 1. What It Says, What It Means (using *Uno's Garden,* Base, 2006)

What It Says	What It Means
1. Uno decides to live in the forest because it is beautiful.	1. The forest is in ecological balance with the appropriate numbers of plants and animals.
2. When the town becomes a city, scientists begin studying the animals.	2. As the city grows, fewer and fewer animals exist until there are none; scientists are compelled to study these organisms before they disappear.
3. Uno remains in the city and continues to tend his garden with a few plants and one animal (snortlepig).	3. Uno's garden is the only source of living plants and a single animal in the decaying city.
4. Uno's children and grandchildren document the gradual return of plants and animals to the deserted city.	4. If left to its own, nature will regenerate itself over time and ecological succession occurs.
5. The forest and the city are in perfect balance again.	5. Plants, animals, and humans can all thrive together with appropriate planning and consideration for all (sustainable ecosystem).
6. The snortlepig is never seen again.	6. The snortlepig died, the species is now extinct, and extinction is forever.

Uno's forest becomes a village, then a city. As the number of people increases, the number of plants and animals decreases. People leave. Uno tends his garden. A snortlepig appears. In the end, Uno and the snortlepig die. Plants grow again and animals return. People again populate the area, but this time they build sustainable homes. The snortlepig is never seen again.

The story illustrates *ecological succession*—the sequence of changes in community development. The inference is that humans need to be aware of the impact they have on their environment and make efforts to live in sustainable ways.

"What It Says, What It Means" helps teach inference. As shown in the left column of Table 1, readers record ideas explicitly stated in the text. In the right column, they make inferences from these ideas. An inference from "The snortlepig is never seen again" is that the snortlepig died, the species is extinct, and extinction is forever. An inference from "Uno's children and grandchildren document the gradual return of plants and animals to the deserted city" is that nature regenerates itself over time and ecological succession occurs.

Inference in Social Studies

> "Inference is the ability to draw a conclusion based on direct or indirect information discerned through conversation or text." (6th-grade teacher)

Readers make inferences based on text evidence and actual outcomes. "Inference Sheet" (Adams & Pierce, 2006) is a strategy used with *Fly Away Home* (Bunting, 1993) to integrate literacy and social studies (see Table 2).

In *Fly Away Home*, a little boy and his father live in an airport. They are homeless. To avoid notice, they sleep sitting up and move from terminal to terminal. The boy resents others who do have homes and wants him and his dad to have their own home. One day the boy sees a bird that has accidentally flown into the airport and is trying to escape. The bird finds a way out and flies to freedom. The story ends on a hopeful note. Like the bird, the boy hopes one day to also fly away home.

The "Inference Sheet" strategy illustrates the relationship between context clues, inferences, and actual outcomes. One relationship in the story involves the father, his son, and the Medina family (another homeless family living in the airport). The little boy's father says he must go to school. The Medina family, who has a son the same age, say their son has to wait before he goes to school. A plausible inference is that the Medina family is here illegally and must remain unnoticed.

Another relationship involves the little boy, a trapped bird, and a jet plane. At the end of the story, the boy looks out an airport terminal win-

Table 2. Inference Sheet for *Fly Away Home* (Bunting, 1993)

Title of Book: *Fly Away Home*

Clue
1) Wear blue jeans, shirts, jackets
2) Sleep sitting up
3) Bird gets caught in main terminal
4) Dad works as janitor on weekends
5) Boy's mother has died
6) Dad says son must start school; Mrs. Medina says her son (same age) can wait
7) Boy sees jet taking off from airport, not landing

Inference
1) Dad & boy blend in with others wearing blue clothing
2) Pretend to be passengers waiting to board a plane
3) Dad & boy are like the bird – caught in the airport
4) Dad has lost his job; Dad can't find a full-time job; Dad is uneducated
5) Dad & boy are homeless because dad quit job to take care of her
6) The Medinas are illegal immigrants
7) Like bird & jet, Dad & boy want to leave and not be homeless

Actual Outcome
1) Dad & boy go unnoticed
2) Another way to stay unnoticed
3) Bird finally escapes main terminal – boy hopes he and Dad will one day do the same
4) Dad determined to find new job
5) Never know why/how mom died
6) Medinas provide childcare for the boy while his dad looks for work
7) Dad & son stay together and work to one day leave the airport and have a home like before.

dow and sees a jet plane taking off. He also sees a trapped bird trying to escape to freedom. A plausible inference is that, like the plane and bird, the boy wants to leave the airport and be free.

Inference in Mathematics

> "Readers use their own schema, connections with the text, and prior life experiences, and combine this thinking with the text evidence (both pictures and words) and clues that the author leaves for the reader to form [original] thinking about the text." (7th-grade teacher)

Inference is often taught as a language-based, cognitive process, but illustrations and picture clues are also important to teaching inference. Text clues help students develop linguistic skills

while picture clues (illustrations) help them develop non-linguistic skills. Together, they provide powerful tools for teaching and learning inference.

"Collaborating with the Author" is a strategy that supports inferential thinking before, during, and after reading (Tovani, 2000). It highlights the importance of textual and picture clues, as well as the processes of inference, prediction, confirmation, and disconfirmation (Goodman, 1996). Table 3 illustrates this strategy, used with *One Riddle, One Answer* (Thompson, 2001) to integrate literacy and mathematics.

One Riddle, One Answer is a story about Aziza, a sultan's daughter who loves numbers and riddles. When the sultan sought a suitable hus-

Table 3. Collaborating with the Author (Tovani, 2000; using *One Riddle, One Answer* [Thompson, 2001])

Text Clues	Picture Clues	Inferences	Predictions	Confirmed	Disconfirmed
1) Her favorite subject was numbers.	Palace is decorated with circles, rectangles, squares.	Riddles are difficult to solve. The riddle deals with mathematics.	Aziza will make riddle very difficult; it will be difficult to solve.		
2) Let any number try to solve the riddle; only one will win. A scholar said the sun; a soldier said a sword.	Numbers are displayed on the flag. Each looks like the number 7.	Neither sun nor sword satisfies all 4 statements in the riddle. The number 7 doesn't, either.	The answer deals with an important number or math concept or both.		
3) A merchant said money, saying that in all matters that count, money always comes first.	Aziza looks dejected. The answers aren't close to solving the riddle.	Answers so far are clues: sun rhymes with the word one; sword looks like the number 1; people count money; much counting starts at the number 1.	The answer to the riddle is something involving a number, probably the number 1.		
4) Ahmed said the riddle speaks of numbers and the answer is the number one.	Design on Persian rugs looks like the number 1; the horse's blanket looks like 1/100; the sand dunes look like 1, 2, 3; the clouds look like 1 X 10 = 10.	The number 1 means different things depending upon how it is used and where it is placed with other numbers.	The answer to the riddle is the number 1.		
The answer to the riddle is the number 1. The riddle illustrates how the number 1 is used as the starting point in counting (1, 2, 3 . . .), as well as how it can be used, depending upon where it is placed, with another number to make fractions (1/100), to make large numbers smaller (19), and to make smaller numbers larger (91).					

band for Aziza, she posed a riddle and agreed to marry whomever could answer it. Many suitors answered but all were wrong. Finally, a farmer named Ahmed provided the correct answer. Aziza and Ahmed were married.

The "Collaborating with the Author" strategy is particularly suited for a teacher read-aloud. Before reading aloud, teachers distribute the strategy sheet. Then they place numbered sticky notes at strategic places in the text—episodic changes, for example—and number the rows on the strategy sheet to correspond with the numbered sticky notes. Teachers read up to the first sticky note, stop, then invite students to record text and picture clues as well as inferences and predictions based on these clues. Teachers then read to the second sticky note and follow the same procedure, inviting students to check whether their predictions are confirmed or disconfirmed. Teachers follow the same procedure until the reading is completed. After reading, teachers invite students to write a brief summary representing their most important understandings of the text.

This story provides an engaging and informative context for seeing relationships between numbers involving the number one. It also highlights implications of these relationships for understanding concepts such as counting, smaller and greater numbers, fractions, and multiplication. From a literacy perspective, the story promotes and supports inferential thinking throughout the text. The following sentences are illustrative:

"He (sultan) had many sons, but only one daughter."

"The riddle has only one true answer."

"Whoever can answer the riddle will be the one I would be happiest to marry."

"Perhaps there will be one," Aziza said. "And one is all that is needed."

"Only one will win the hand of the sultan's daughter."

"Will you hear one more answer?" Ahmed

CONNECTIONS FROM READWRITETHINK

Teaching Inference
These resources from ReadWriteThink.org show additional ways to teach inference.

Inferring How and Why Characters Change
Students will really get into character when they read short stories and analyze the how's and why's of characters' behaviors.

http://www.readwritethink.org/classroom-resources/lesson-plans/inferring-characters-change-858.html

Author Study: Improving Reading Comprehension Using Inference and Comparison
"Reading between the lines" can be as crucial to comprehension as understanding the words on the page. Through guided author studies, students experience the benefits and the limitations of inference.

http://www.readwritethink.org/classroom-resources/lesson-plans/author-study-improving-reading-906.html

How to Encourage Higher Order Thinking
Practicing Higher Order Thinking (HOT) skills outside of school will give kids the tools that they need to understand, infer, connect, categorize, synthesize, evaluate, and apply the information they know to find solutions to new and existing problems.

http://www.readwritethink.org/parent-afterschool-resources/tips-howtos/encourage-higher-order-thinking-30624.html

Lisa Fink
www.readwritethink.org

said. (Thompson, 2001)

Each sentence illustrates the importance for readers to infer multiple meanings of the word "one." In this story, the word "one" refers to the number one (the answer to the riddle) and also to one person (one suitor can offer only one answer). In addition to these linguistic clues, the story includes beautiful illustrations that provide visual clues for answering the riddle. The combination of linguistic and visual clues provides readers with a holistic view of making inferences from text.

Inference in Language Arts

"When teaching inference, I say look for evidence in the novel or story to back up any information and draw a conclusion about a character or situation." (7th/8th-grade teacher)

Readers use background knowledge with text clues to make inferences. "BK + TC = I" (Harvey & Goudvis, 2007) is a strategy used with *The Watertower* (Crew, 1994) to teach inference in language arts (see Table 4).

The Watertower is a mystery in which a rusted watertower stands on the outskirts of a town. It has a logo printed on the side. One day Bubba and Spike climb the watertower for a swim in the tank. Afterwards, Bubba loses his swimming trunks. Spike runs to get another pair. Bubba swims in the tank again and emerges a changed boy. He now possesses the same crazed expression people in town wear whenever they look at the watertower. Bubba shuts the hatch and heads home. The townspeople wait for him and for the next person who swims in the watertower.

One way for teachers to use the "BK + TC = I" strategy is to first do a book chat focused on mystery stories. Next, have students record background knowledge about mystery stories and share favorite mystery writers. During reading, students can record text clues and inferences based on these clues. In literature circles after reading, students should note and discuss inferences similar to or different from their own.

> *It is important that teachers across all grade levels and content areas teach inference.*

Final Thoughts

"I would say [inference] is embedded in everything that I do because the basis of inference is thinking about text on your own." (Middle School Reading Specialist)

It is important that teachers across all grade levels and content areas teach inference. One reason is that inference is an important academic

Table 4. "BK + TC = I" ("Background Knowledge + Text Clues = Inference" using *The Watertower* [Crew, 1999])

Background Knowledge	Text Clues	Inference
Mystery stories are fun and exciting to read. My favorite mystery writers include Edgar Allen Poe, Agatha Christie, Arthur Conan Doyle (Sherlock Holmes stories), and Nathaniel Hawthorne. Gary Crew is a famous writer from Australia. He writes creepy mysteries. Some aren't solved. He leaves that up to the reader. The settings are rural towns and involve mysterious objects. Characters find more than they hoped for.	1) The watertower stood on Shooters Hill casting a long, dark shadow across the valley . . . . 2) Bubba climbed into the tank. "I'll be all right," he muttered. "I'll be all right." 3) Then something moved. Something Bubba couldn't quite make out. 4) "My mother will be worried. You know what a worrier she is. She'll be scared something happened to me, won't she?" 5) Bubba shut the hatch with a thud. Deep in the tank, the water eddied and swirled.	1) The watertower is ominous and affects everybody in the valley. 2) Bubba is frightened of swimming in the tank and thinks something is lurking in the water. 3) There was something evil on top of the tower waiting for Bubba to come back to the top. 4) Something bad has happened to him. Maybe something, or somebody, has taken control over him and is now making him believe things that aren't true. 5) Bubba has been changed. Although the hatch is closed, the watertower is waiting for the next victim.

and life skill. In fact, it has been identified as a 21st century skill that is required for success in a complex, changing world. It is also a tested skill, appearing more and more on national and state standardized tests. Moreover, it is being tested across content areas and in a variety of ways, such as inferring meaning from charts and graphs (math and science), inferring meaning from cultural and social change over time (social studies), and inferring themes, character actions and motives, and author's purpose (language arts). Still another reason is that teaching inference, like the teaching of reading and writing, is not the sole responsibility of the English/Language Arts teacher. Inference is an interdisciplinary concept involving thinking and learning skills that extend throughout the curriculum. Thus, all content area teachers need to teach students how to make inferences, to "read between the lines," and, even more important, to think between the ears.

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Appendix A: Picturebooks

English/Language Arts

Base, G. (2008). *Enigma*. New York, NY: Abrams Books for Young Readers.
Buchholz, Q. (1999). *The collector of moments*. New York, NY: Farrar, Strauss and Giroux.
Crew, G. (1999). *The watertower*. New York, NY: Crocodile Books.
Jennings, P. (1992). *Grandad's gift*. New York, NY: Viking Press.
Johnson, A. (1996). *The aunt in our house*. New York, NY: Orchard Books.
Joy, N. (2007). *The secret Olivia told me*. East Orange, NJ: Just Us Books.
Macauley, D. (1990). *Black and white*. New York, NY: Houghton Mifflin.
Muth, J. (2008). *Zen ties*. New York, NY: Scholastic.
Tan, S. (2004). *The lost thing*. Vancouver, BC: Simply Read Books.
Van Allsburg, C. (1986). *The stranger*. New York, NY: Houghton Mifflin.
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Social Studies

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Fox, M. (2000). *Feathers and fools*. San Diego, CA: Harcourt.

Garland S. (1994). *I never knew your name*. New York, NY: Ticknor & Fields.

Hazen, B. S. (1979). *Tight times*. New York, NY: Puffin Books.

Innocenti, R. (1985). *Rose Blanche*. Mankato, MN: Creative Education.

Levine, E., & Nelson, K. (2007). *Henry's freedom box*. New York, NY: Scholastic Press.

Sakai, K. (1990). *Sachiko means happiness*. San Francisco: Children's Book Press.

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Science

Bardoe, C. (2006). *Gregor Mendel: The friar who grew peas*. New York, NY: Abrams Books for Young Readers.

Base, G. (2006). *Uno's garden*. New York, NY: Abrams Books for Young Readers.

Dyer, S. (2002). *Five little fiends*. New York, NY: Bloomsbury Children's Books.

Eversole, R. (1995). *Flood fish*. New York, NY: Knopf Books for Young Readers.

Hooper, M. (1998). *The drop in my drink*. New York, NY: Viking.

Kramer, S. (1995). *Theodoric's rainbow*. New York, NY: Scientific American Books for Young Readers.

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Locker, T. (1995). *Sky tree: Seeing science through art*. New York, NY: HarperCollins.

Parker, S. (1995). *Isaac Newton and gravity*. New York, NY: Chelsea House.

Swope, S. (2004). *Gotta go, gotta go*. New York, NY: Farrar, Straus and Giroux.

Weisner, D. (1992). *June 29, 1999*. New York, NY: Clarion Books.

Wick, W. (1997). *A drop of water*. New York, NY: Scholastic.

Mathematics

Anno, M. (1995). *Anno's magic seeds*. New York, NY: Philomel Books.

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Appendix B: Young Adult Literature

English/Language Arts

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Jennings, P. (2005). *Funniest stories*. New York, NY: Viking.

Selznick, B. (2007). *The invention of Hugo Cabret*. New York, NY: Scholastic.

Tan, S. (2009). *Tales from outer suburbia*. New York, NY: Arthur A. Levine Books.

Social Studies

Feelings, T. (1995). *The middle passage: White ships/black cargo*. New York, NY: Dial Books.

Levine, K. (2002). *Hana's suitcase*. Morton Grove, IL: Albert Whitman.

Tan, S. (2007). *The arrival*. New York, NY: Arthur A. Levine Books.

Walker, S. M. (2005). *Secrets of a civil war submarine*. Minneapolis, MN: Carolrhoda Books.

Science

Morgan, J. (2002). *Born with a bang*. Nevada City, CA: Dawn Publications.

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