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Middle School Matters Field Guide:
Research-Based Principles, Practices, and Tools

Chapter 1: Research-Based Instruction

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The Meadows Center
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Chapter 1:
Research-Based Instruction

Introduction

This section focuses on instructional practices that are based on rigorous intervention research conducted primarily over the last decade in reading, writing, mathematics, and cognitive science and reasoning. Many of these research-based instructional strategies apply across various content areas and are designed to enhance students' content area learning, increase engagement, and maximize students' ability to recall, apply, and synthesize information. For example, summarization strategies can be implemented in social studies, science, or language arts; class-wide discussion practices can be used in mathematics to explore problem-solving methods and enhance reasoning ability.

When these strategies are implemented school wide, students experience consistency (for example, one strategy for identifying main idea rather than seven) and have the opportunity to apply and practice strategies in various contexts. These repeated exposures help students generalize the use of these strategies to other areas—in and outside of school and beyond the middle grades.

The content dimensions included in this section on research-based instruction are

- Reading and Reading Interventions
- Writing and Writing Interventions
- Mathematics and Mathematics Interventions
- Cognitive Science and Advanced Reasoning

Practical tools for implementing these practices can be found on the following web page: https://greatmiddleschools.org/toolkits/.

Reading and Reading Interventions

Extensive research and numerous syntheses have been conducted in the area of reading instruction and intervention for middle grades students with reading difficulties. In particular, the Institute of Education Sciences has issued a guidance document to assist schools in making research- and evidence-based decisions about improving instruction for adolescents with reading difficulties.[1] This section uses extant research and data to provide an overview of nine research- and evidence-based principles for improving reading achievement for all students and gives specific examples of research- and evidence-based interventions to support students who are reading below grade level. These principles are accompanied by specific practices that schools and teachers can implement, followed by examples of activities and lessons that can be used with students to improve reading.

In elementary school, reading may be considered an independent subject, but in middle school, reading is involved in all subject areas, so every teacher should be considered a reading teacher. Therefore, the reading strategies in this section should be implemented school wide, as part of a school culture that works toward high levels of student achievement in reading. Specific interventions and strategies are provided to support students who struggle to learn to read and perform below grade level, as well as students who are English language learners (ELLs). Providing opportunities for students to practice these reading strategies in every subject every day will enhance development of the reading skills they need to become better readers and more accomplished students.

Principle 1:

Establish school wide practices for enhancing reading for understanding in all content area instruction.

Providing appropriate and adequate reading instruction for middle grades students is the responsibility of all content area teachers (including those who teach English language arts, science, social studies, mathematics), and teachers of English language development classes for students learning English. There are several instructional practices that content area teachers can use to enhance reading opportunities for all students without detracting from content area instruction.

Practice 1: *Identify key words for learning, teach at least two words*[a] *per class every day, and review one word from previous instruction.*

This practice can be readily implemented across all content area instruction and provides students with opportunities to expand their academic vocabulary, increase their background knowledge, and better understand the key ideas about which they are reading and learning. For example, a social studies teacher delivering a unit on political and economic systems could teach two new words that relate to the learning they will be addressing that day, such as *socialism* and *depression*. Then, the teacher could review a word that is related but was previously taught, such as *federalism*. One way teachers can accomplish this practice is to select words in a unit that are high priority and high utility. Assuming that a unit is three weeks long, a teacher can determine the key words students will need to know and explicitly teach them each week. The teacher and students can review the vocabulary in subsequent weeks as related content allows for further exploration of the terms, as well as opportunities to use academic language in reading and writing about the content.

There are several ways important vocabulary words can be taught and reviewed, including the following three methods:

1. Teachers can take advantage of vocabulary maps[2] that use the key word and a student-friendly definition, show pictures of the word, provide related words, and give examples of how the word can be used.

2. Teachers can demonstrate the relationships between words using a concept map that starts with an overarching topic or concept and branches out along lines and arrows to component academic and technical vocabulary, examples, characteristics, and graphics or symbols.[3]

3. Teachers can teach key words that students use in their written and oral arguments for a debate or a structured discussion.[4, 5]

The types of strategies described above support the learning of all students and are particularly helpful to students learning English.[4] However, teachers need to be aware that students who are not yet proficient in English will need additional help to master academic vocabulary that may be familiar to native English speakers (e.g., words like *compare* or *analyze*).

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[a] *Learning just two words a day is insufficient for students learning the English language or those who are seriously behind their peers; therefore, the number of new words per day will depend on the needs of the students.*

Practice 2: *Instruct students to ask and answer questions while they read to monitor comprehension and learning.*

Students who are actively engaged while listening and reading are more likely to understand and remember what they hear or read.[6, 7, 8] Teachers can promote this practice by instructing students in how to ask and answer questions while they are reading. Some questions teachers can use while modeling the practice include the following:

- What is about the "big idea" or main point of the reading?
- How does this relate to the vocabulary we are learning?
- In what way did the previous step, event, or action influence what happened?
- How does this key character or historical figure behave and why does he behave this way?
- How does the author support his or her point?

Teachers should "think aloud" to demonstrate how they consider what kind of information a given question is targeting, where in the text important information related to the question is located, and how to use information in the text to both answer a question and develop a question that can be used to self-monitor learning and comprehension.

Another way to help students be actively engaged in their reading is to ask them to develop one question to ask the class once they have completed their reading. Teachers can use sample question stems to help students develop their own questions.

PRACTICE 2 EXAMPLE APPLICATION: Sample Question Stems

- How did what happened at the end differ from _____?
- How would you compare _____?
- How do you think the author could have better written the _____?
- What do you think would happen if _____?
- How do you think _____ might have been prevented?
- How would you interpret _____?
- Why do you think the author _____?
- Who else do you think could have influenced _____?
- What was the most important finding related to _____?

Note: Generating questions will also be addressed in Principle 4, Practice 1, which expands on the use of comprehension strategies for self-monitoring while reading complex texts.

Practice 3: *Teach students to comprehend the relationships among ideas using graphic organizers.*

Graphic organizers (see examples in Figures 1 and 2) have been associated with improved vocabulary knowledge and comprehension, particularly when used with informational text.[9, 10, 11] These learning tools have an advantage over traditional outlines because they can present a single visual display of the relationships among a variety of ideas in a text. The arrangement of the information on the page can support students in understanding how details support main ideas. Graphic organizers include matrices, webs, maps, and diagrams. The particular format of the graphic organizer should align with the purpose of the lesson. The examples that follow demonstrate the difference in how information is arranged to show a comparison-contrast and to show the steps of a process.

If the graphic organizer does not match the structure of the information, the value of the tool might be lost. Therefore, teachers need to provide appropriate graphic organizers and show students how to select or design these tools to support their understanding of content and concepts. Variations of graphic organizers are mentioned in Principle 1, Practice 1 (vocabulary and concept maps); Principle 7, Practice 1 (advanced organizers); and Principle 8, Practice 1 (learning logs).

When introducing a new graphic organizer, teachers should explain the format and what kind of information that it should contain. Then, teachers should model how to complete an organizer, using information or vocabulary from a text. Students need time to practice using the tool with feedback from their teacher before they can be expected to apply it independently.

PARTS OF A CIRCLE

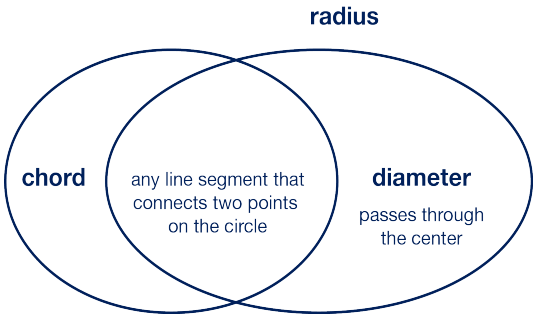

FIGURE 1. Example graphic organizer for comparing and contrasting the parts of a circle

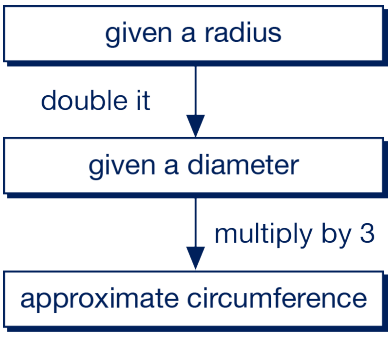

FIGURE 2. Example graphic organizer to show the steps in determining the circumference of a circle

Principle 2:

Teach word-meaning strategies within content area classes.

Middle school students' knowledge of general academic terms used across the content areas has been linked to their academic achievement.[12] But cross-discipline word knowledge is only part of what students need to know to be successful in their classes. Content areas (e.g., mathematics, science, social studies, English language arts) each have unique vocabulary used to communicate concepts and explain processes.[13] These discipline-specific concept words are the center of learning the big ideas and are used in conjunction with general academic vocabulary to communicate essential information. Students need to learn what these words mean and how to use them within the multiple contexts of reading, writing, and speaking. Reviews of research on academic vocabulary instruction have found evidence of effectiveness for the following two practices: explicit instruction in important words and instruction in word learning strategies.[5, 14]

Practice 1: *Provide explicit instruction for important words.*

Teachers identify the important academic or concept words students need to learn to master the key ideas being taught. They introduce these words with a picture, video, or other demonstration to make the words vivid.[15] Teachers then engage students in a discussion about what the words mean and don't mean, extending this understanding to the text and important ideas they are learning. A critical next step for teachers is to return to these words regularly throughout the lesson and instructional unit to ensure that students can correctly use the words in speaking and writing tasks.[16] It is important that students be taught the meaning of vocabulary words in the context of learning and also the multiple meanings of words. Exploring the different meanings of words as used in different contexts is also recommended for supporting ELLs, who tend to know fewer words and fewer definitions for multiple meaning words than native English speakers.[4, 17]

Resources for implementing this practice can be found online at the Middle School Matters Institute website:

- Vocabulary Maps Toolkit
  https://greatmiddleschools.org/toolkits/reading/vocabulary-maps/
- Frayer Model Toolkit
  https://greatmiddleschools.org/toolkits/reading/frayer-model/

Practice 2: *Provide instruction in word-learning strategies.*

Although explicit instruction is important (Practice 1), the sheer number of words students need to learn requires that they develop strategies for independently determining the meanings of unfamiliar vocabulary. One means of equipping students to understand the content area terms they encounter is to teach morphemes (prefixes, roots, and suffixes) and how they contribute to the meaning of words.[5, 14] Research conducted with middle school students has found their awareness of morphemes is related to their academic vocabulary knowledge and contributes significantly to their reading comprehension.[18] Other research indicates the practice of using morphemes systematically, coupled with multiple opportunities for practice, is particularly effective for English language learners.[4] This process can be facilitated by applying learned morphemes to words used in different content areas.

PRACTICE 2 EXAMPLE APPLICATION: Morpheme Examples Across Content Areas

Root word: circu(m)—going or moving around

- English language arts: circumlocution = circum + locut + -ion
- Math: circumference = circum + fer + -ence
- Science: circulation = circu + lat(e) + -ion
- Social studies: circumnavigate = circum + navig + -ate

Another word-learning strategy involves teaching word meanings directly through the use of a mnemonic word association and a picture that ties together the word clue and the definition.[19, 20] The following is an example of this kind of mnemonic strategy:

PRACTICE 2 EXAMPLE APPLICATION: Making Mnemonic Connections for Words

Teachers can use the following figure to present the word *analyze* to students. The teacher would show the card to students and explain the mnemonic connections among the picture, the play on words with "ant's eyes," and the definition.

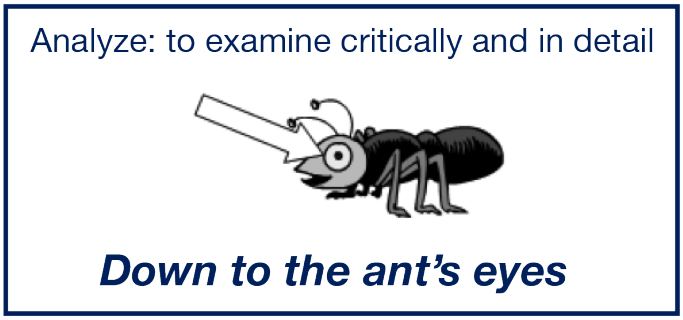

FIGURE 3. Example of mnemonic connection for the word *analyze*

Principle 3:

Activate and build appropriate background knowledge for understanding text content.

Researchers report that background knowledge is important to adolescents' reading comprehension.[15, 21] A lack of prior knowledge can make reading and understanding informational texts particularly challenging for native English-speaking students and English language learners alike.[22, 23]

Practice 1: *Instruct students to use text to support answers.*

Successful use of text evidence requires adequate preparation to help students attend to pertinent information as they read. The following are examples of anticipatory statements that could be used in the different content areas to stimulate students' thinking before reading:

- English language arts—The narrator in a story is a reliable source of information.
- Mathematics—It is always better to use π than 3.14.
- Science—It is important to keep everything as clean and free of bacteria as possible.
- Social studies—The use of trade embargoes is an effective diplomatic tool.

These statements are generated based on key concepts about to be encountered in a text and are considered anticipatory because students must determine whether they could or could not adequately support the statement on the basis of their prior learning. Asking students to consider these statements prior to reading about the targeted information makes them aware of their current understanding and beliefs. As students read the new text, they will look for additional or novel text evidence to support or amend their views. It is important to note that the statements are not phrased in a true-or-false format, which would ultimately require students to locate and know a single, correct answer. Rather, the statements are open to alternative viewpoints that can be supported with evidence from different sources.

During and after reading the text, teachers should instruct students to consider whether the author presented text-based evidence for particular positions on the key ideas or concepts. Students should be asked to evaluate the evidence in the text and elaborate on why their initial views could or could not be supported. According to researchers, this technique requires students to identify related background knowledge in their memories to link to the statements and provide adequate justification for their responses.[24] When used in connection with text reading, it encourages students to return to important information to obtain further elaboration for their responses.[15]

Activating students' thinking about key concepts prior to reading is particularly important for assisting English language learners and students with learning disabilities in drawing upon relevant knowledge that can be used to support comprehension of new and unfamiliar information.[22] It also focuses students' attention on what is most important in the text so that they are not distracted by interesting but insignificant details.

Principle 4:

Teach students to use reading comprehension strategies while reading complex text.

Students benefit from using reading comprehension strategies while reading complex text. Without sufficient instruction, adolescents tend to proceed through text with little understanding of what they are reading or awareness of when their comprehension has broken down.[25, 26] Students' understanding improves when they can recognize they are not adequately understanding text and use "fix-up" strategies to build comprehension.[27]

Practice 1: *Instruct students to generate questions while reading to build comprehension.*

Teaching students to generate questions while reading is one way of getting them to stop at regular intervals to think about what is being communicated and how the information relates across paragraphs. Studies have shown that this practice can increase comprehension of content area text for students of different ability levels.[7, 27, 28] Table 1 shows the different levels of questions students can be taught to generate in support of their comprehension. Level 1 questions are the most literal because they are based on a fact that can be identified in one place in the text. Level 2 questions require students to combine information that is located in two different parts of the text. Level 3 questions relate information in the text to something the reader has experienced or learned previously.

Resources for implementing Practice 1 can be found online at the Middle School Matters Institute website:

- Generating Leveled Questions
  https://greatmiddleschools.org/toolkits/reading/generating-leveled-questions/

Practice 2: *Instruct students to generate main ideas at regular intervals in a text.*

Another means of encouraging students to be active readers and monitor their own comprehension is to teach them how to generate a main idea statement for single or multiple paragraphs and to use the key idea to make connections to previous and current learning.[31] Adolescents who learn to identify the explicitly or implicitly stated main ideas of a text demonstrate increased understanding and recall of important information.[32] Using a strategy referred to as *Paragraph Shrinking*[31] or *Get the Gist,*[27] students at a range of ability levels and language backgrounds have been successfully taught to use three steps to generate a main idea statement:

1. Identify the key "who" or "what" that is the focus of the paragraph or section.

2. Determine the most important information about what the key person, place, or thing has, is, or does.

3. Succinctly state the "who" or "what" and most important information about him, her, or it in a sentence.

Get the Gist will also be addressed in Principle 8, Practice 1, which expands on this and other strategies by having students work collaboratively on reading tasks.

	Level 1: Right There	**Level 2: Putting It Together**	**Level 3: Making Connections**
English language arts	Who is Atticus Finch in *To Kill a Mockingbird* appointed to defend?	How does Boo Radley show kindness toward Jem and Scout?	How is Atticus Finch similar to and different from the father figure in *Much Ado About Nothing?*
Mathematics	What information is given in the problem?	What math symbols/language/equations will I need to represent the problem statement?	How do I know if my solution is reasonable?
Science	What is the rate of change of velocity over time?	What are two vector quantities included in Newton's Laws?	How is physics related to other sciences?
Social studies	When did the Berlin Wall fall?	What two events led to the end of the Cold War?	How was the Cold War different from a conventional war?

TABLE 1. Levels of Questions to Support Reading Comprehension[29, 30]

Principle 5:

Provide intensive reading interventions to students with reading problems.

Although the expectation is that students will learn to read with understanding before advancing to middle grades, the reality is that many students reach the middle grades and are unable to read grade level text effectively and with understanding.

Students in middle grades with demonstrated reading difficulties have performed significantly better in reading when provided supplemental reading interventions that directly address their vocabulary, comprehension, and word-reading challenges.[32, 33, 34, 35] This includes students who are English language learners experiencing difficulty beyond what is attributable to their language proficiency levels.

Practice 1: *Identify students who are two or more grade levels behind in reading and provide daily reading intervention.*

Students who have reading difficulties should be provided with approximately 50 minutes per day of supplemental reading instruction delivered by a trained professional[b] who is focused on the student's instructional needs.[33] The first step in providing students with specific interventions is to identify whether the student's reading comprehension difficulties are a function of:

- Word reading or decoding problems;
- Word meaning or vocabulary problems;
- Insufficient background knowledge to understand text;
- Unusually slow or dysfluent text reading; and/or
- Inadequate use of reading comprehension strategies to promote reading comprehension.

Through diagnostic assessment, teachers can determine which of the above are contributing to reading difficulties and target their instruction.

The following is a description of an intervention that was associated with improved outcomes among students in grades 6–8.[33, 34, 36]

[b] *This type of intensive reading intervention should include a research- and evidence-based intervention with a professional educator specifically trained in the instructional approach. This instruction would be based on the student's needs identified through diagnostic assessment.*

PRACTICE 1 EXAMPLE APPLICATION: Phase II and III of a Reading Intervention

In Phase II of the intervention, the emphasis of instruction was vocabulary and comprehension, with additional instruction and practice provided for applying the word study and fluency skills and strategies learned in Phase I. Lessons occurred over a period of 17–18 weeks, depending on student progress. Word study and vocabulary were taught through daily review of the word study strategies learned in Phase I by applying the sounds and strategy to reading new words. Focus on word meaning was also part of word reading practice. Additionally, students were taught word relatives and parts of speech (e.g., *politics, politician, politically*). Lastly, students reviewed how to apply word study skills to spell words correctly. Vocabulary words for instruction were chosen from the text read in the fluency and comprehension component.

Teachers used similar activities three days a week during social studies lessons. Two days a week, teachers used novels with lessons developed by the research team. Fluency and comprehension were taught, with an emphasis on reading and understanding text through discourse or writing. Students spent three days a week reading and practicing comprehension of expository social studies text, and two days a week reading and practicing comprehension of narrative text in novels. Content and vocabulary needed to understand the text were taught prior to reading. Students then read the text at least twice with an emphasis on reading for understanding. During and after the second reading, comprehension questions of varying levels of complexity and abstraction were discussed. Students also received explicit instruction in generating questions of varying levels of complexity and abstraction while reading (e.g., literal questions, questions requiring students to synthesize information from text, and questions requiring students to apply background knowledge to information in text), identifying main ideas, and summarizing text. Strategies for addressing multiple choice, short answer, and essay questions were also considered.

Phase III continued the instructional emphasis on vocabulary and comprehension, with more time spent on independent student application of skills and strategies. Phase III occurred over approximately 8–10 weeks.

Principle 6:

Guide students during text-related oral and written activities that support the interpretation, analysis, and summarization of text.

Students understand, remember, and analyze text when provided with opportunities to reflect on what they read through discussions and written responses.

Practice 1: *Foster discussion among small groups of students.*

To encourage reading for understanding, teachers should provide opportunities for students to return to texts a number of times to explore, discuss, and revise their developing understanding of the ideas and concepts.[7] These opportunities can be fostered through the use of reciprocal teaching, a multi-component strategy intended to support student comprehension.[37, 38] To implement reciprocal teaching, the teacher initially leads discussion about the text until students learn to assume different roles for independently engaging in small group discussions. These roles include summarizer, questioner, clarifier, or predictor. After reading a short section of text (generally a few paragraphs at first, but increasing to several pages with practice), the *summarizer* highlights the key points for the group. Then, the *questioner* helps the group consider and talk about what was read by posing questions about anything that was unclear, puzzling, or related to other information presented. In this portion of reciprocal teaching, students could apply the question generation skills addressed in Principle 1, Practice 2 (*Instruct students to ask questions while they are reading or when listening to the teacher read to monitor comprehension and learning*) and Principle 4, Practice 1 (*Instruct students to generate questions while reading to build comprehension*) that will support asking about more than surface-level information.

The *clarifier* in the small group of students is responsible for seeking out portions of text that will help answer the questions just posed, although all members of the group participate in discussing the information and connecting ideas. By interacting in this way, students are driven back to the current selection and possibly, to other readings to look for text evidence in support of their responses. Finally, the *predictor* offers suggestions about what the group can expect to read in the next section of text. These suggestions activate relevant background knowledge, set a purpose for reading, and relate new information to that just discussed by the group.

It is important to explicitly teach each of the strategies or roles involved in reciprocal teaching before having students carry them out. Training in the procedures has led to greater reading comprehension outcomes for English language learners.[39]

Practice 2: *Instruct students in how to summarize text.*

Summarizing text involves succinctly and coherently relating the main ideas and significant details of a passage. When adolescents are explicitly taught to work collaboratively on summarizing informational text, such as is done in reciprocal teaching, they reach higher levels of comprehension and retain more content information.[27, 40, 41]

Teachers must thoroughly explain and model each step in the summarizing process multiple times with different types of text before students will be able to generate a summary in collaborative groups or, eventually, on their own. The following is an example of steps students can learn to follow to create a summary of text.[42]

PRACTICE 2 EXAMPLE APPLICATION: Instruction in Summarizing Text

Using the following steps, students can learn to create a summary of text:

1. List all the main ideas in the passage.
2. Underline the most important terms or phrases in the main ideas or cross out any information that is less significant.
3. Combine related terms and phrases, and any significant details that can create a complete sentence. Repeat this step until all important information has been combined into sentences.
4. Number the sentences in an order that will make sense and reflect the organization of the ideas in the text.
5. Write a complete paragraph containing the sentences.
6. Revise and/or edit the paragraph to finalize the summary.

Practice 3: *Enhance text understanding through teacher-guided conversations.*

Structured opportunities for students to interact with their teacher and peers in discussions about texts have been found to improve content learning and reading comprehension as well as the language acquisition of English language learners.[15, 43] One approach called, "Questioning the Author" provides students with well-scaffolded instruction that supports their interactions with texts and with other students in the class as though the author were available to them for comment and conversations.[44] This approach is different from the self-questioning practices described in Principles 1 and 4, in part because it is more narrowly focused on the clarity and organization of the message being communicated by the author. The idea is to have students actively engage with text and think about the information and the way it is written from multiple perspectives. Students ask and answer questions in a lively teacher-led discussion. The teacher provides several distinct goals for reading and several queries that facilitate students' success in reaching these goals.

The following procedures are necessary:

1. Select an engaging text that is either narrative or expository.

2. Assure students have adequate background knowledge to understand the text.

3. Identify key ideas and concepts prior to reading to support understanding and deep thinking about text.

4. Teach students to grapple with ideas while reading and evaluate how well and thoroughly an author communicated particular ideas. Also, teach them to watch for bias or lack of representation of alternate views in the writing.

5. Have students share what they are reading through discussion but focus on understanding the text—not on the discussion per se.

6. Direct the discussion through questions such as, "What is the author trying to tell us?" and "Why do you think the author is saying that?"

7. Guide students in learning that the text is relevant but an inadequate source of all information.

It is believed that below grade-level readers are empowered by these types of interactions, because they profit not only from hearing their peers' interpretations of text but also from observing other classmates work through issues comprehending text.[45]

Principle 7:

Maximize opportunities for students to read and connect a range of texts.

Middle grades teachers have a range of readers in their classrooms, creating challenges when assignments require text reading. For this reason and possibly others, many classroom teachers require students to read very little either inside or outside of class time. Teachers also report that they increasingly rely on reading text aloud or using media, such as videos, to provide students with content knowledge because they perceive text reading as inaccessible to many students.[46] Yet for students to acquire skill in reading and understanding text, they must have opportunities to read a range of text types (e.g., textbooks, letters, descriptions, original documents, poetry). Findings of a study comparing teacher read-alouds to student silent reading of informational text suggest that students provided effective vocabulary and comprehension instruction can understand and recall content equally well when reading text silently.[8] Teachers should consider implementing the following practices to enhance opportunities for students to read and respond to text.

Practice 1: *Provide an advanced organizer of the key ideas and key words to better prepare students to read text.*

Teachers can facilitate activation of students' background knowledge and supplement this background knowledge prior to reading. This is not the same as "front loading" where teachers tell students what they are going to read prior to reading. Activating and extending background knowledge assists students in successfully preparing to understand and learn from what they read.[15, 21] Teachers can present (e.g., orally, on the board, or through a handout) and explain the key ideas and words, including any proper nouns, prior to reading. This will help correct any misconceptions and reduce the distraction of insignificant details. It will also help students understand the vocabulary and focus on comprehending what they are reading. Activating and supplementing background knowledge, such as by using advanced organizers, is particularly important for English language learners and students with learning disabilities.[22, 23]

Practice 2: *Read for a specified amount of time (e.g., 3 minutes) and then provide a prompt for student response.*

The amount of cumulative reading students do is associated with academic achievement.[47] Teachers should provide daily opportunities for students to read and respond to text for instructional purposes. The time allocated for this exercise can range from a minimum of 2 minutes for reading and 1 minute for responding, to multiple intervals of 3–4 minutes for reading and 1–2 minutes for responding.[8] Students can be asked to respond to predetermined prompts such as, "What is the 'big idea' or main point of this section?", "How does the author describe _____?", or "What did you learn about _____?" Students can respond in writing using learning logs or orally by turning and talking with a partner for 1 minute.

Practice 3: *Have students participate in partner reading.*

Teachers can create reading partners by pairing a stronger reader and a slightly weaker reader, and then ask the pairs to take turns reading the same passage, with the better reader going first. Students can partner read for a specified amount of time (e.g., 3 minutes) and afterwards use 1–2 minutes to write about the main idea, write and answer a question, or summarize the text.[33] Repeatedly reading the text has the advantage of offering English language learners and those with reading difficulties a chance to (1) hear a peer model reading, (2) practice their own skills in reading aloud, and (3) review content multiple times to increase their understanding of new information.[48]

Principle 8:

Organize students into collaborative groups for reading tasks.

Student involvement and learning can be enhanced through well-structured collaborative groups.[41, 49] These groups can be designed to promote both individual and group accountability, and they can be used in English language arts, mathematics, social studies, and science classes. According to research, when collaborative groups are implemented two or more times per week, reading comprehension improves.[27]

Practice 1: *Implement collaborative groups with strategic reading practices to improve student outcomes.*

Opportunities for students to collaborate with their peers can be beneficial if structured appropriately. Some teachers ask students to work initially in pairs and then move into a group; other teachers find it better to start with small cooperative groups. One example of a reading comprehension practice that uses collaborative grouping structures is Collaborative Strategic Reading (CSR) which has two important phases: Phase One, where students learn four reading comprehension strategies, and Phase Two where students work in groups to apply what they have learned.[27]

The four reading comprehension strategies taught in the first phase include previewing text (*preview*), monitoring comprehension while reading by identifying key words and concepts that are challenging (*click*, when students understand the words; *clunk*, words students have trouble understanding), thinking about the main idea while reading and putting it into your own words (*get the gist*), and summarizing text understanding after you read (*wrap up*). Once students have developed proficiency using the four strategies with teacher guidance, they are ready to use these same strategies in peer-led cooperative learning groups.

Organizing Cooperative Groups: Experienced teachers are aware that students will not function equally well in a group and that groups are more effective when teachers carefully select students to make a well-functioning team. When implementing CSR, teachers assign approximately four students to each group with the following considerations: (1) each group should have a student who can serve as group leader, and (2) the group should consist of members with varying reading abilities. Teachers assign students to roles in the group and teach them to perform those roles. Assignment of group members rotates on a regular basis (e.g., every couple of weeks) so that students can experience a variety of roles. It is important that English language learners and students with learning disabilities be full participants and not be relegated to the easiest role all the time.[50] With appropriate support, all students can take responsibility for leading application of each of the four strategies in Collaborative Strategic Reading. Student roles help ensure that all group members have a meaningful task and participate in the group's success.

Resources for implementing this practice can be found online at the Middle School Matters Institute website:

- Collaborative Strategic Reading (CSR) https://greatmiddleschools.org/toolkits/reading/csr/

What is the teacher's role when students are working in their cooperative groups? Teaching students their roles and how to implement them effectively within a cooperative group is an important first step. When students are working in their collaborative groups, the teacher's role is to circulate among the groups, listen to students' participation, read students' learning logs and, most importantly, provide clear and specific feedback to improve the use and application of the strategies. Teachers can help by actively listening to students' conversations and clarifying difficult words, encouraging students to participate, and modeling strategy usage and application.

PRACTICE 1 EXAMPLE APPLICATION: Four Roles for Students During Group Work

1. **Leader:** Provides overall group management that includes keeping students engaged, guiding the group through the reading, and assuring strategy experts are doing their tasks and students are using their learning logs.

2. **Clunk Expert:** Reminds students to look for clunks as they read and use strategies to resolve clunks.

3. **Gist Expert:** Assures that students determine the most important "who" or "what" in the section of text they are reading and then identify key information to include in writing gists. The Gist Expert guides students to write gists with the most important information and no unnecessary details.

4. **Question Expert:** Helps students write and answer questions about the entire text they have read. Question Experts may use question stems (discussed in Principle 1, Practice 2) to help members of their group write successful questions.

PRACTICE 1 EXAMPLE APPLICATION: Learning Logs

It is expected that students will need assistance learning to work in cooperative groups, implementing the strategies, and mastering academic content. One way to provide structure is through the use of learning logs.[27] A learning log, or written record, promotes effective implementation of cooperative groups. A learning log can be revised or developed to suit the particular focus of the classroom teacher, but typically, learning logs provide a procedure for students to record key information about each of the four strategies: preview, click and clunk, get the gist, and wrap up. They also provide written documentation of the groups' functioning for the teacher to review. An example of a learning log template is provided in Figure 4.

Sample Learning Log	
Name:_____	**Date:_____**
Brainstorm: What do you know about this topic?	**Predict: What do you think you will learn by reading this passage?**
Clunks: List your Clunks for each section you read.	
The Gist (main idea): Write a Gist for each section you read.	
Write questions: Write questions using Who, What, Where, When, Why, or How.	**Review: Write a summary of the most important information you learned.**

Source: Adapted from Texas Center for Reading and Language Arts. (2000).[51] For use in the classroom, this figure should be expanded to fill an entire page.

FIGURE 4. Sample Learning Log

PRACTICE 1 EXAMPLE APPLICATION: Steps for Applying Cooperative Learning Groups

1. Provide students with ample opportunity to practice the four strategies (preview, click and clunk, get the gist, and wrap up) so that they are sufficiently familiar with using them and, with prompting and support, can perform them independently in their groups.

2. Assign students to mixed ability groups with a composition of talent and personality that allows them to be functional.

3. Assign roles to group members. Typically having four students in each group works well, with each student assigned one of these roles: leader, clunk expert, gist expert, and question expert.

4. Before assigning students to groups and after teaching the strategies, provide a model for how the group should work by selecting students to role play in front of the class.

Practice 2: *Implement team-based learning to clarify, apply, and extend students' understanding of text and content.*

Team-based learning (TBL) offers another means of having students work in collaborative groups.[54] To implement TBL for reading comprehension, teachers heterogeneously group four to five students to work together at least once every 10 days on a deeper examination of text. After providing explicit instruction in important words (see Principle 2, Practice 1) and building background knowledge (see Principle 3), teachers pose a complex question designed to guide students' learning of the content in a unit. For example, an American history teacher might ask, "Why were the American colonists willing to fight for their independence from the British?" Teachers lead an initial discussion about the question to prepare students to read the text and check students' understanding while they read the text.

A TBL Knowledge Application activity offers the small group of students an opportunity to return to the text after reading it to consider different perspectives, solve problems, or present conclusions.[11] In the American history class, students might be asked to compare two primary sources to examine Patrick Henry's and John Dickinson's perspectives on whether to separate the colonies from Britain and declare their independence. After working together to gather text evidence on the issues surrounding independence from England, the team would have to prepare a speech for the Second Continental Congress, either supporting independence or urging unity. The team would prepare arguments by using all information, readings, discussions, and activities from across the unit of instruction. Students would also prepare to address opposing arguments offered by teachers or fellow classmates.

The teacher would close the TBL Knowledge Application activity by returning to the complex question posed at the beginning of the unit and facilitating a final discussion of that question among students.

Principle 9:

Discontinue using practices that are NOT associated with improved outcomes for students.

Teachers and educational leaders are required to make daily decisions about students' learning and behavior. While educators would prefer to rely on evidence-based practice, determining what constitutes evidence-based practice can be a confusing and haphazard enterprise. Typically, educational leaders or teachers attend a conference or other educational venue and discover a new practice they hope will solve a problem. Often they are successful at promoting the implementation of this practice at the district- or school-level, resulting in professional development and other trainings to prepare teachers to implement the practice. New ideas and practices provide hope that change can benefit students. However, many of these ideas and practices are unproven and, therefore, result in false hopes for educators and disappointing outcomes for students.

Practice 1: *Take stock of all of the instructional practices and models that teachers are currently implementing and determine whether they are necessary and associated with improved outcomes for students.*

After making a list of all the reading-related practices you are using, determine if adequate evidence supports their continued use. This evidence may be derived from published studies that document effects of the specified treatment or from analyzing data in your school or district database that indicate how students are performing.

One common practice in middle grades is to attempt to assess and use learning styles as a means of enhancing outcomes, particularly for students from diverse linguistic and cultural backgrounds and students with special needs. Recent reports support considering students' individual learning needs and maximizing opportunities for all students to learn. However, the vast majority of instruments designed for educators to determine students' learning styles have no demonstrated reliability or validity.[52] Furthermore, many of the practices recommended to enhance instruction linked to the learning styles of students have no demonstrated efficacy or clear connection to pedagogy. [53]

The following website is a reliable place to identify evidence-based practices.

What Works Clearinghouse: http://ies.ed.gov/ncee/wwc/

Conclusion

The interpretation of the practical implications for the research on reading and reading interventions designed for use in the middle grades was derived from many sources and syntheses. In particular, the following syntheses were influential:

- Flynn, L. J., Zheng, X., & Lee, S. H. (2012). Instructing struggling older readers: A selective meta-analysis of intervention research. *Learning Disabilities Research & Practice*, *27*, 21-32. doi:10.1111/j.1540-5826.2011.00347.x[32]

- Kamil, M. L., Borman, G. D., Dole, J., Kral, C. C., Salinger, T., & Torgesen, J. (2008). *Improving adolescent literacy: Effective classroom and intervention practices: A practice guide* (NCEE 2008-4027). National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education. Retrieved from http://ies.ed.gov/ncee/wwc/pdf/practice_guides/adlit_pg_082608.pdf[1]

- Wanzek, J., Vaughn, S., Scammacca, N. K., Metz, K., Murray, C. S., Roberts, G., & Danielson, L. (2013). Extensive reading interventions for students with reading difficulties after grade 3. *Review of Educational Research*, *83*(2), 163-195. doi:10.3102/0034654313477212[35]

Multiple research studies informed the principles and practices presented in this section. The level of evidence for the findings ranges from relatively low to moderately high. However, for many of the practices, the findings are proximal to the tasks taught.[41] For example, research on teaching word meanings in content area classes indicates that words that are deliberately taught and practiced are more likely to be learned than when not taught; however, less is known about the overall influence of these practices on vocabulary learning more broadly.[55]

There is a moderately high level of evidence for teaching students to use reading comprehension strategies while reading text.[41] Less is known, however, about how many strategies are necessary and whether the use of strategies generalizes to other types of reading. It is known that providing students with more background knowledge about a topic makes them more likely to comprehend texts on the topic. However, precise methods for extending background knowledge across the range of topics students are required to read and learn is less well understood.[15, 21, 22, 23] It is known that students who demonstrate reading difficulties in the middle grades are responsive to interventions.[33] However, these interventions may require more extensive (multiple years) and intensive (daily small groups) instruction than schools currently have the resources to support.[34, 35] No principle has been suggested for which there are not caveats and requirements for future research. These principles are based on the best and most current research, and schools implementing them in sensible and contextually responsive ways are likely to yield benefits for student learning.

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Reading And Reading Interventions

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Writing and Writing Intervention

To be effective writers in the middle grades, students must understand that writing is a tool to support learning in all content areas. Students must master writing processes, knowledge, and skills to improve their effectiveness as writers. What follows is a description of seven important principles to help middle grades students develop their skills as writers and their use of writing to support their learning.

The first principle for Writing and Writing Interventions describes research- and evidence-based practices for using writing in all content areas. These practices include taking notes, summarizing what is learned, writing for specific purposes, and answering questions. The second principle defines the characteristics of a good writer, describes the writing and revision process, and provides specific examples of strategies to help writers improve. The third principle provides research- and evidence-based strategies for writing with a word processor and for developing keyboarding skills. The fourth principle provides practical ways to assess student writing that provide feedback to improve their writing and opportunities for them to assess their own writing and the writing of other students. The fourth principle also stresses the importance of assessing writing to identify students with writing difficulties who will need extra, intensive writing instruction.

The fifth principle describes methods for providing more intensive writing instruction to students who are in need of writing intervention because of difficulties in this area. The sixth principle cautions against traditional approaches to teaching grammar skills. Finally, the seventh principle examines ways to improve how writing is taught through professional development and opportunities for teachers to work together to contribute to the success of the middle grades writing program. Each principle is described and accompanied by specific practices and examples for schools to follow.

Principle 1:

Establish consistent school wide practices for using writing as a tool to support student learning in all content areas.

Writing about material read and presented in content classes improves students' learning and understanding.[1, 2, 3, 4] Writing about ideas presented in a class or classroom text enhances learning because it affords greater opportunities for students to think about the ideas; requires them to organize and integrate the ideas into a coherent whole; fosters explicitness; facilitates reflection; encourages personal involvement with the concepts to be learned; and involves students transforming ideas into their own words.[5] Moreover, when students paraphrase and convert text into their own words, they are not simply engaged in rote learning—a shallow form of learning.[6,7,8,9] To ensure that writing to learn occurs in all content areas, it needs to be a school wide goal.

Practice 1: *Ask students to analyze, interpret, or personalize in writing information that has been read or presented.*

When students write analyses, interpretations, and personal responses to reading and material presented in class, they develop broader and better understanding of that material. Examples of writing activities that encompass analysis and interpretation include: (1) analyzing and interpreting the motivations of a character in a novel; (2) writing a paper to show how to apply ideas presented in a science or mathematics class; and (3) analyzing material presented in a social studies class to develop a particular point of view. Examples of personal responses include writing a personal reaction to a historical event or writing about a personal experience related to material read or presented.

Practice 2: *Ask students to provide written summaries of material read or presented in class.*

Written summaries of material read or presented in class require students to consider the fundamental essence of the material. Students need to make decisions about which material is most important and how ideas are related one to another. The permanence of a written summary creates an external record of this synopsis that can be readily critiqued and reworked. As a result, summary writing improves comprehension of the material being summarized.

Practice 3: *Ask students to take written notes about material read or presented in class.*

Taking written notes about material read or presented in class enhances understanding. Note taking involves determining which information is most relevant and then transforming and reducing the substance of these ideas into written phrases or key words. Note taking requires students to organize the abstracted material in some way and connect one idea to another. They can then blend new information with their own knowledge to come to new and deeper understandings.

Practice 4: *Ask students to answer questions in writing about material read or presented in class.*

Answering questions about text or material presented in class can be done verbally, but there is greater benefit from answering questions in writing. Recording answers makes them more memorable, as writing an answer provides a second form of rehearsal. Written answers can then be available for review, re-evaluation, and reconstruction at a later date. In addition, having students create their own written questions to answer in writing can improve understanding because it requires students to think about what information is most important.

PRACTICE 1 EXAMPLE APPLICATION: Analyzing, Interpreting, or Personalizing in Writing Information Read or Presented in Class

Before, during, and/or after reading material for a class or participating in a classroom activity, students are asked to use writing to analyze, interpret, and/or personalize ideas. For example, before completing a science experiment, students are asked to write their predictions and rationale for each prediction. During the experiment, they are asked to revisit their predictions and justifications and revise as necessary. Once the experiment is completed, students revise their written predictions as needed and explain in writing the reasons for these changes. At each point, students' written predictions and justifications or explanations are used to foster discussion about students' beliefs, as well as their misconceptions about the topic of the science experiment.

Other examples of analyzing, interpreting, and personalizing writing activities that content teachers can use to promote student learning are listed below. Each of these activities can be used as a springboard for class discussion about the topic.

- **Guided journal writing:** As students read a short story for their language arts class, they keep a journal where they respond to it by answering one or more open-ended questions. For example, they can be asked to analyze why they think a character acted as he or she did and indicate what they would do in a similar situation and why.

- **Analytic essay:** After a classroom presentation about the causes of the American Revolution, students might be asked to write an essay in which they identify what they think are the three main causes of the conflict and explain the contribution of each.

- **Application essay:** After studying the principles underlying the operation of an inclined plane, students are asked to indicate in writing how they would use this principle to climb a hill, design a ramp to move material from a lower spot to a higher one, or design a plow.

PRACTICE 2 EXAMPLE APPLICATION: How to Teach Students to Summarize Material Read or Presented in Class

Students can be directly taught the following rules for how to write a summary:

- Identify or select the main information.
- Delete trivial information.
- Delete redundant information.
- Write a short synopsis of the main idea and supporting information for each paragraph.

A good starting point for teaching these rules is to begin with a paragraph of text. The teacher first explains each summary rule and its purposes. Use of the rules is then modeled as the teacher applies them to producing a summary of the paragraph. Modeling continues until students are ready to summarize paragraphs with teacher assistance. Guided practice continues until students can effectively apply the rules to summarize paragraphs by themselves. The teacher and class then begin to apply the rules to longer text, as well as class lectures.

Students can be directly taught how to write a summary using an outline as the starting point of the summary.

With this approach, summarizing centers on the creation of a skeleton outline of the material. For example, when summarizing text, students begin by creating a skeleton outline, starting with a thesis statement for the passage. Next, they generate main idea subheadings for each section of the text and add two or three important details for each main idea. They then convert their outline into a written summary of the whole text. As with the example of teaching summarization rules above, instruction begins with the teacher explaining the skeleton outline procedure and its purpose, modeling how to apply it, providing guided practices until students can apply it independently, and expanding its use to different types of text and classroom presentations.

PRACTICE 3 EXAMPLE APPLICATION: Structured Note-taking Procedures

Structured note taking involves creating a written organizational structure for material read or presented in class.

The Cornell Note-Taking Method

1. With this note-taking system, students divide their paper into two columns: a note-taking column on the right and a question and/or key word column on the left. The bottom two inches of the page are left blank and are not divided by the line between the two sections. This will later serve as a summary section for the notes.

2. Notes from class or from reading material are written in the right-hand column (i.e., note-taking column). These notes are paraphrased from the main ideas of the text or lecture. In addition to text, symbols and abbreviations can also be used to record information.

3. Relevant questions or key words that will help with future study are written in the left-hand column.

4. After notes have been completed, students can write a brief summary on the bottom two inches of the page. When using the notes as a study aid, students can cover up the note-taking column to answer questions or define key words on the left side of the page.

5. The Cornell note-taking method needs to be explicitly taught, with teachers describing the procedure and its rationale, modeling how to apply it, and providing guided practice in its use.

Concept Mapping

Concept mapping is another approach for helping students organize their notes about material read or presented in class. Students place each important concept in a circle and then show how the concepts link together using words and lines. One way of teaching this strategy is to first present a model of an *expert concept map* for a particular reading. After discussing this map, students then practice completing other *expert maps* that are incomplete, moving from more to less complete maps, until they can create their own map for material read.

1. Students are introduced to expert-created models.

2. Students complete partially filled in expert models.

3. Students are given word lists and concept links to help them create their own concept maps.

4. Students create concept maps independently.

PRATICE 4 EXAMPLE APPLICATION: Answering Questions in Writing and Teaching Students to Generate Their Own Written Questions

Answering questions in writing involves writing responses to questions given at specific points during a classroom activity (before, during, or after) or questions inserted into text or presented at the end of it. For example, students may be asked to write short answers in full sentences to four questions (one detail, two inferences, and one main idea) after reading a segment of text, after which they check and correct their responses before reading the next segment of text.

Generating questions in writing is a strategy in which students create written questions about information presented in class or material read. For instance, when teaching students to write and answer questions about material read, they are first taught the difference between a good and bad question. They then practice generating and answering their own questions about text. If they cannot answer one of their questions, they generate a new one that can be answered. A sequence for teaching this question-generation strategy is presented below:

1. Students are given models of questions written by the teacher.

2. Students identify good and poor questions, indicating why each is good or poor.

3. Students are taught to identify main ideas that serve as the core of the questions they will generate.

4. The teacher models how to generate good questions.

5. Students practice generating questions with teacher assistance until they can do so effectively.

Principle 2:

Explicitly and systematically teach students the processes, knowledge, and skills of effective writing.

To write effectively and use writing as a tool to support learning, students must master basic writing processes, knowledge, and skills.[10] Students must be knowledgeable about the characteristics of good writing and the features of specific types of text (e.g., persuasive writing), and they must possess effective strategies for planning, drafting, revising, editing, and sharing such texts. Students must be able to construct sentences that are grammatically correct and accurately express their intended meaning and purpose. Basic writing skills, such as spelling, must be mastered so that they do not interfere with other writing processes. Because writing tasks are contextually bound (e.g., the nature of persuasive writing differs across disciplines), teachers in each discipline must take responsibility for teaching students how to use writing in their discipline, and such efforts need to be coordinated across departments within a school.

Practice 1: *Analyze and emulate model text to discover the characteristics of good writing and the features of specific types of text.*

Students' writing is influenced by their knowledge of the characteristics of good writing and of the specific text type they are creating.[11, 12] Students can acquire this knowledge by analyzing and emulating exemplary models.[3, 13, 14] Research suggests that the use of models is an effective strategy for providing middle grades students with illustrations of genre-specific features, such as the essential elements of a persuasive argument, as well as for developing their awareness of more general aspects of good writing, such as word choice and sentence construction. Having students analyze model text also provides teachers with an authentic segue into another beneficial strategy: establishing specific product goals.[15, 16] Given the relative ease and demonstrated efficacy associated with using models and product goals, teachers should consider using these two procedures with each type of writing they expect from their students.

To realize the benefits of using models, teachers should first clarify exactly what they want students to learn. For instance, a social studies teacher who will be teaching students how to write a persuasive argument might begin by reviewing the relevant grade-level standards. With that framework in mind, the teacher would next select several model texts that effectively illustrate those criteria. Several kinds of texts can serve as models, including compositions that teachers write specifically for the purpose of modeling, writing samples from students themselves, and authentic texts. Many middle grades teachers find that authentic texts related to topics students find personally relevant and interesting work well as initial models. The social studies teacher might, therefore, select several recent newspaper editorials about potential cuts in school funding because students have expressed sincere interest and concern about how this reduction affects them.

As noted previously, teachers can readily pair the use of models with another strategy shown to improve middle grades student writing—establishing product goals.[14] Research suggests that goals are most effective when they are specific and at a level of difficulty that is challenging, yet attainable.[13] Given that students in most middle grades classrooms represent a range of writing proficiency levels, it is often necessary and beneficial to use a combination of common goals (i.e., features and qualities of writing that apply to all students in the class) and individualized goals (i.e., features and qualities of writing that are selected based on each student's strengths and needs).

Using the previous persuasive writing example, the class-developed list of "Must Haves!" could serve as the framework for common goals. Collaboratively, the teacher and each student (or, in some instances, the teacher and a small group of students who have similar writing strengths and needs) would identify additional individualized goals. As students' writing skills develop, their goals should be

revised to ensure they remain appropriately challenging. As will be described in Principle 4, specific product goals can be used as a guide for assessing student growth.

PRACTICE 1 EXAMPLE APPLICATION: Model Texts

To initiate students' analysis of model texts, the social studies teacher could interactively think aloud and pose questions that direct students' attention to the targeted text elements and qualities.

I see the author started with a series of questions. Why do you think that is? What does the author do in this section to convince us of her position? How do the content and format of this author's conclusion compare and contrast with the others we've examined?

Once students develop a basic understanding of the criteria in question, the teacher could then facilitate a class discussion that results in the development of a list of essential features (or what students might refer to as "Must Haves!") for persuasive arguments based on the analysis of the newspaper editorials. For example, they might generate the following five features:

1. An introduction that gives the position.
2. Multiple reasons that make sense and have details.
3. Evidence and examples for each reason.
4. Possible arguments against the position.
5. A convincing conclusion.

Working in pairs or small groups, students could next analyze other model texts. What follows is an example of how the teacher could guide and support students during this activity by breaking it down into a two-step process.

Step #1: As you read the text, use colored pencils to underline each "Must Have!" for a persuasive argument.

- An introduction that gives the position. RED
- Multiple reasons that make sense and have details. BLUE (Number each R1, R2, R3...etc.)
- Evidence and examples for each reason. GREEN (Number each R1-D1, R1-D2...etc.)
- Possible arguments against the position. PURPLE
- A convincing conclusion. BROWN

Step #2: Look back at the text and answer the following questions:

1. Did the author include all of the "Must Haves!"? If not, what was missing?

2. What do you think the author did well?

3. What recommendations would you offer to the author to improve the text?

PRACTICE 1 EXAMPLE APPLICATION: Establishing Product Goals

Below are examples of persuasive argument goals for two students. Each reflects the common goals established by the social studies class (i.e., "Must Haves") but is individualized to meet the students' unique needs.

Aida.
Aida includes few, if any, of the necessary elements in her persuasive writing and expresses herself using very simplistic language. Therefore, her goals are:

- Include an introduction that gives my position.
- Include at least three reasons that make sense and have details.
- Include evidence and examples for each reason.
- Include a possible argument against my position.
- Include a convincing conclusion.
- Use exciting, interesting, "come to life" words to make my argument more convincing.

Miguel.
Miguel's persuasive arguments already include most of the key elements, but his sentence structure tends to be repetitive and he does not include transitions between ideas or paragraphs. Therefore, his goals are:

1. Include an "attention grabber" introduction that gives my position.
2. Include at least five reasons that make sense and have vivid details.
3. Include evidence and examples for each reason.
4. Include at least two arguments against my position.
5. Include a "hit it home" convincing conclusion.
6. Use different kinds of sentences—including questions—throughout the text.
7. Use transition words to guide the reader.

Practice 2: *Model and teach strategies for planning, drafting, revising, editing, and publishing written work.*

In order to write effectively, students need to learn a variety of strategies for carrying out the various processes involved in writing.[10] Strategies for planning, drafting, revising, editing, and publishing text are among the key elements that students must learn. Students also need to learn to use these strategies flexibly, selecting the right strategy for a specific task and effectively adapting selected strategies as needed. Teachers should employ a gradual-release model when teaching writing strategies, where the strategy and its rationale are described and discussed, the strategy is modeled by the teacher, guided practice in applying the strategy is provided, and deciding when and how to apply the strategy in new writing situations is emphasized.

Explicitly teaching middle grades students how to use writing strategies has a dramatic effect on multiple aspects of writing, including overall quality, length, number of genre elements, and time spent planning.[3, 11, 18, 19] Teachers interested in helping their students become strategic writers need to first identify what strategy or strategies would be appropriate and beneficial for students to learn. For instance, different strategies would need to be selected for situations in which one or two students experience difficulty brainstorming and organizing their ideas, versus a small group of students struggling to accomplish a specific writing task, versus an entire class finding it extremely difficult to revise writing in meaningful ways.

Along with considering the strategy that should be taught, teachers need to decide which instructional approach is most likely to help students learn to independently apply the strategy. A substantial body of empirical research shows that one specific instructional model, Self-Regulated Strategy Development (SRSD), is particularly effective with diverse populations of students, including those who are in middle school.[3, 11, 13, 17, 19, 20] SRSD uses explicit and systematic instruction to help students learn strategies for planning, drafting, and revising text, as well as strategies for accomplishing specific writing tasks, such as writing a persuasive argument or expository essay. With SRSD, students increase their writing knowledge and learn to use the same self-regulation procedures that skilled writers rely on to manage the writing process (e.g., goal setting, self-monitoring, self-instruction, self-reinforcement). Other noteworthy characteristics of SRSD include individualized instruction, criterion-based rather than time-based learning, authentic writing tasks, a positive classroom environment, and collaboration among teachers and students. SRSD instruction occurs in six flexible, recursive stages:

1. **Develop Background Knowledge**: Students are taught relevant background knowledge they will need to understand and use the strategy successfully.

2. **Discuss It**: The strategy is introduced and its purpose and benefits are described and discussed.

3. **Model It**: Teacher, peer, and/or collaborative modeling are employed to show how the strategy is used.

4. **Memorize It**: Students engage in a variety of activities to learn the steps of the strategy.

5. **Support It**: The students practice using the strategy in a series of scaffolded composing activities.

6. **Independent Use**: Students independently apply the strategy in appropriate contexts.

Many SRSD strategies include mnemonics to help students remember and apply the steps. An example of one SRSD strategy to improve middle grades students' expository writing is shown in Figure 1 (additional SRSD examples are described in Practice 5 and can be found in the work of Graham, Harris, and colleagues).[17, 21]

Three excellent Web-based resources for learning more about SRSD follow:

Project Write
http://www.kc.vanderbilt.edu/projectwrite

The Iris Center: Self-Regulated Strategy Development (SRSD)
http://iris.peabody.vanderbilt.edu/module/srs/

The Iris Center: Improving Writing Performance
http://iris.peabody.vanderbilt.edu/module/pow/

Resources for implementing this practice can be found at the Middle School Matters Institute website:

- **Writing Strategies and Self-Regulated Strategy Development Toolkit**
  https://greatmiddleschools.org/toolkits/writing/writing-strategies-and-srsd/

PLAN & WRITE: A Strategy for Planning and Drafting Expository Essays

How do you plan a good essay? Follow steps in **PLAN***:*	
Pay Attention to the Prompt	Read the prompt. Decide what you are being asked to write about and how you will develop your essay.
List Main Ideas	Brainstorm possible responses to the prompt. Decide on one topic and then brainstorm at least ___ main ideas for the development of your essay.
Add Supporting Ideas	Think of details, examples, or elaborations that support your main ideas.
Number Your Ideas	Number major points in the order you will use them.
How do you plan more as you go? Follow steps in **WRITE**:	
Work from your plan to develop a thesis statement.	
Remember your goals.	
Include transition words for each paragraph.	
Try to use different kinds of sentences.	
Exciting, interesting, million-dollar words should be used.	

FIGURE 1. Example of Self-Regulated Strategy Development Strategy.[22, 23, 24, 25]

Practice 3: *Teach students how to construct more complex sentences.*

A basic skill is crafting ideas into sentences that accurately express the writer's meaning and intention.[10] This skill requires being able to use a variety of different types of sentences, ranging from simple to complex, to create text that is clear and can be read fluidly. Strategies for teaching sentence construction skills include teaching students how to combine simpler sentences into more complex ones; deconstructing complex sentences into simpler ones; and expanding sentences by including additional details in an existing sentence. One benefit of these strategies is that usage and grammar skills are acquired as a byproduct of combining, deconstructing, and expanding sentences.[25, 26] Teachers should employ a gradual-release model in which the sentence construction skill is modeled and students are provided guided practice in applying it, as it is essential that instruction include students applying the taught skill to their own writing in order for them to truly grasp the concept.[27]

Resources for implementing this practice can be found at the Middle School Matters Institute website:

- **Sentence Combining Toolkit**
  https://greatmiddleschools.org/toolkits/writing/sentence-combining/

PRACTICE 3 EXAMPLE APPLICATION: Sentence Combining Skills Instruction

Targeted sentence skill: Constructing a sentence with an adverbial clause, using a connecting word (*because*, *after*, *until*, and *when*).

Sentence combining involves teaching students to construct more complex and sophisticated sentences through exercises in which two or more basic sentences are combined into a single sentence. To teach students how to write a complex sentence with an adverbial clause using a connecting word, the teacher first models how to combine two smaller sentences that allow such a construction. Modeling may involve a single connecting word (e.g., *because*) or provide several connecting words from which the teacher makes a choice (e.g., *because*, *until*, *when*).

Model combining: "My friends went to the fair."

"My friends wanted to have fun." (because)

Into one sentence: "My friends went to the fair because they wanted to have fun."

The teacher should continue to model combining such sentences, but ask the students for help. Once students have mastered the basic idea through teacher modeling, they should practice combining similar small sentences into a single complex sentence with an adverbial clause. This practice can be done independently, in small groups, or both. Teachers should provide students with needed assistance and feedback on the correctness of their combinations. Very importantly, students should be asked to apply what they learned in their writing. This can be done by asking them to revise a prior piece of writing so that they combine smaller sentences into a complex sentence with an adverbial clause using connected words, or by asking them to write new text where they demonstrate the use of this skill. This basic teaching format (Figure 2) can be used to teach a variety of different kind of sentences.

Teaching Format	Action
Model	Demonstrate the skill and establish why it is important.
Guided Practice	Provide students with assistance until they can apply the skill correctly and independently.
Application	Ask students to apply the skill when they write (monitor performance and provide individualized support, as needed).

FIGURE 2. Sample Teaching Format for Teaching Different Kinds of Sentences

Practice 4: *Refine students' spelling, grammar, and usage skills.*

Judgments about the quality of a student's writing are influenced by factors other than the quality and organization of their ideas. Papers with spelling, grammar, and usage errors are judged more harshly than papers without such miscues.[28, 29] Such judgments are even less favorable for typed papers than they are for handwritten ones.[30] In addition, needing to devote conscious attention to grammar and spelling may disrupt students' other writing processes. For example, having to think about how to spell a word while in the middle of writing a sentence may cause the student to forget the rest of the sentence.[31, 32] Given the relationship between foundational skills and writing processes, it should not come as a surprise to learn that when middle grades students are provided with opportunities to improve their foundational skills (such as spelling and handwriting), the quality of their compositions improves.[33]

PRACTICE 4 EXAMPLE APPLICATION: Connecting Word Meaning to Spelling

One way to refine middle grades students' spelling skills is to teach them how word meanings and spelling skills are connected. A first step in this process is to teach students the meaning and spelling of common Greek and Latin roots, along with common prefixes and suffixes.

One way to introduce common prefixes or suffixes is to start with a word-sorting activity in which two or more patterns are contrasted (e.g., words ending in *-able* and *-ible*). With word sorting, a master word is established for each spelling *(debatable, edible).* The teacher then takes other *-able* and *-ible* words and sorts them into the appropriate category, providing clues about the meaning of the two suffixes (i.e., "able to do, or fit to do") and how to tell when to use each (i.e., when *-able* is removed from the word, a complete word is usually left, whereas a complete word is not typically left when *-ible* is removed). The teacher solicits student help in sorting the words until the class can define the meaning of the two suffixes and the basic rule for spelling them. Students can then generate their own *-able* and *-ible* words, identifying exceptions to the rule (e.g., *accessible*). In addition to word sorting, students can be asked to study the spelling of specific *-able* and *-ible* words and generate permissible words by adding *-able* to Old French and Anglo-Saxon words (e.g., *lament*) or *-ible* to common Latin roots (e.g., *aud*).

Another activity for refining middle grades students' spelling words involves having them add prefixes and suffixes to common Greek and Latin roots (e.g., *meter, tele, oper*) to make as many permissible words as possible. For this exercise, students should also define each word.

Principle 3:

Establish word processing as the common medium for student writing.

Word processing makes the writing process easier.[34] It is easy to change, add, delete, and move electronic text produced on a word processor. Word processers include software—such as spelling and grammar checkers—that assist writers, and printed electronic text is neat and easy to read. Word processors can be connected to other electronic sources (such as the Internet), where information about writing topics can be located. Students who use word processing as their primary medium for writing make greater progress over time than those who rely on paper and pencil.[3, 13, 34, 35] Thus, middle grades students must be taught computer skills if they have not already acquired them.

Practice 1: Make enough word processors available in the school so that all students can use them to complete writing assignments.

Today, students do most of their writing outside school on computers or other electronic devices. Students need to use the same writing tools at school as they use at home—tools that they will eventually use at work. The available evidence also indicates that students who use word processing (versus pen or paper) as their primary means of composing at school show greater improvements in the overall quality of their writing.[3, 13, 34, 35]

Access To Computers

Most middle grades classrooms have one or two computers—not nearly enough for students to use word processing as their primary tool for writing in the classroom. While the eventual goal should be that each class has enough computers so students can do most or all of their writing via word processing, many middle grades schools likely need to build capacity over time. One starting point is to create word processing labs where students or classes can work on their writing. Another starting approach is to have rolling word processing labs where computers are stored on a cart and brought directly to the classroom. In either case, schools will need to add additional computer capacity and mechanisms for maintaining equipment if middle grades students are to use word processing as their primary writing tool in all content classes.

Practice 2: Teach keyboarding skills and how to use word processing programs and software.

The positive benefits of word processing are limited or negated for students with little word processing experience or poor typing skills. These students typically produce better compositions when writing by hand than they do when composing via word processing.[32] Consequently, students need to become fluent typists and learn how to use word processing and software designed to support their writing.

Instruction In Word Processing

Typing instruction is not part of most middle grades schools' curriculum anymore. Learning how to touch type and use a word processor should be offered as an elective or embedded within a specific content class. Such instruction should be limited to those students who need it, however, because many middle grades students will already have good typing and word processing skills.

Principle 4:

Assess and monitor student writing to improve instruction and identify students who require more intensive writing instruction.

Assessing student progress in writing provides teachers with needed information for adjusting classroom instruction.[30, 37] Assessments also provide a mechanism for identifying students who need more intensive assistance with writing or writing instruction.[38] In addition, teaching students how to evaluate their own writing and establishing procedures for them to provide and receive feedback about their writing from their peers helps students improve their writing.[14]

Practice 1: *Monitor students' progress as writers.*

When teachers assess or monitor a student's writing progress, it has a positive impact on the student's overall progress as a writer.[36, 37] Such assessments range from frequently (weekly) assessing student classroom writing in terms of ideas, organization, voice, word choice, sentence fluency, and usage/conventions, to judging (at least yearly or more often) student performance on more formal and standardized writing measures. Such assessments provide teachers with information on the effectiveness of their writing instruction and whether they need to make changes in what they are doing. These assessments also provide mechanisms for identifying students who need more intensive assistance and instruction in learning to write.

The complexity of writing necessitates that assessments be multi-faceted and target both writing processes (i.e., planning, drafting, revising, editing, publishing) and products (the texts students produce in response to a writing task).

Observations.

Although there is limited research on validated ways to assess student writing processes, many teachers find it beneficial to gather data by carefully observing students while they compose and examining their written work for relevant information.

For example, teachers can seek answers to questions such as:

1. How long does the student spend planning before actually writing?
2. Does the student use any tools or techniques to organize ideas before drafting (e.g., graphic organizers or outlines)?
3. When the student revises and edits his or her work, are meaningful improvements made to the text?

Teachers can also have conversations with students to learn about their writing knowledge and attitudes.[39, 40] Examples of questions that could be used for this purpose include the following:

1. What are some of the ways good writers plan what they want to say before they begin writing?
2. When you revise your writing, how do you go about doing so?
3. What kinds of writing do you enjoy?
4. How do you think writing relates to your future goals?
5. What do you think are your writing strengths?
6. What do you think would help you become a better writer?

Rubrics

To assess the quality of students' writing products, many middle grades teachers use analytic and/or primary trait rubrics. An analytic rubric is a criterion-referenced scoring guide that targets characteristics that are generally associated with good writing. A commonly used example is the *6+1® Trait Rubric* which targets ideas, organization, voice, word choice, sentence fluency, conventions, and presentation.41 There is a 5- and 6-point version of the *6+1® Trait Rubric* for middle grades students.

These rubrics can be downloaded for free at
http://educationnorthwest.org/resource/464

Analytic rubrics can be beneficial for identifying a student's relative strengths and needs, monitoring a student's writing development over time, and planning and differentiating instruction.

In contrast with analytic rubrics, primary trait rubrics are developed for specific writing genres or tasks. Primary trait rubrics can be used to evaluate the overarching goals and purpose(s) of a particular writing task (e.g., present a clear, convincing argument) and/or specific text features (e.g., thesis statement, supporting reasons with details, conclusion). Because primary trait rubrics are more closely aligned with writing tasks, many middle grades teachers find them helpful for assessing and developing student content-area writing skills (e.g., a historical narrative, a science lab report). Teachers who want to create a primary trait rubric often begin by consulting the relevant grade-level standards to identify appropriate criteria for the targeted writing task. Figure 3 presents an example of a simple primary trait rubric an eighth grade teacher in Texas might develop using the five criteria for imaginative stories found in the state's English language arts and reading standards.[42] To develop a more sophisticated version of this rubric, the teacher could expand the scoring scale (e.g., 0–4) and write performance descriptors that correspond to each score for each element.

Although rubrics may have potential benefits, it is recommended that middle grades teachers use them in combination with other assessment practices—such as feedback from adults and peers and self-evaluation—that research suggests will produce positive and consistent improvements in students' writing.[28, 37, 43]

Name:	**Story Title:**		
Elements	**0** **Not Evident**	**1** **Evident, but Would Benefit from Further Attention**	**2** **Evident and Well-Developed**
Sustains reader interest			
Includes well-paced action and an engaging story line			
Creates specific, believable setting through the use of sensory details			
Develops interesting characters			
Uses a range of literary strategies and devices to enhance the style and tone			
Comments:			

FIGURE 3. Sample Primary Trait Rubric for an Imaginative Story

Curriculum Based Measurement

Another research-validated form of assessment for writing products is writing curriculum based measurement (W-CBM).44 W-CBM can be used to identify students who are experiencing writing difficulties (screening) and monitor students' writing progress over time (progress monitoring). With W-CBM, teachers administer short probes at regular intervals to quantify a student's level of writing proficiency.45 W-CBM is appropriate for use with all middle grades students but is recommended, in particular, for students who are experiencing writing difficulties because it is highly sensitive to small increments of progress. Middle grades students should be given 30 seconds to think about and plan their text and 7 minutes to write. The prompts used for W-CBM probes can be narrative or expository, as appropriate for a particular student and subject area.

Scoring W-CBM:

The recommended scoring procedure for W-CBM is correct minus incorrect word sequences (CIWS). CIWS is calculated by subtracting the number of incorrect word sequences from the number of correct word sequences, which is described as follows:

- **Correct Word Sequences (CWS):** The total number of adjacent, correctly spelled words that are syntactically and semantically correct within the context of the sample. When scoring for CWS, a vertical line is first placed where a sentence should end and then all incorrect words are underlined. Correct word sequences are marked by putting an upward-facing (blue) caret above the two words.

- **Incorrect Word Sequences (IWS)** are marked by putting a downward-facing (red) caret below the two words. Carets are also placed at the beginning of each sentence to score for correct/incorrect capitalization and at the end of each sentence to score for correct/incorrect punctuation.

- **Correct Minus Incorrect Word Sequences (CIWS):** The number of IWS (final count of downward facing [red] carets), subtracted from the number of CWS (final count of upward facing [blue] carets).

Although there are other scoring options for W-CBM (e.g., total words written and words spelled correctly), they demonstrate less technical adequacy than CIWS with middle grades students.[46, 47, 48] Figure 4 is a W-CBM sample produced by a sixth grade student scored using CIWS (Figure 5). In this instance, the student was given a choice of several story starter prompts, such as:

1. *One day, we were playing outside the school and…*

2. *I was talking with my friends when all of a sudden…*

3. *It was a dark and stormy night…*

4. *I found a note under my pillow that said…*

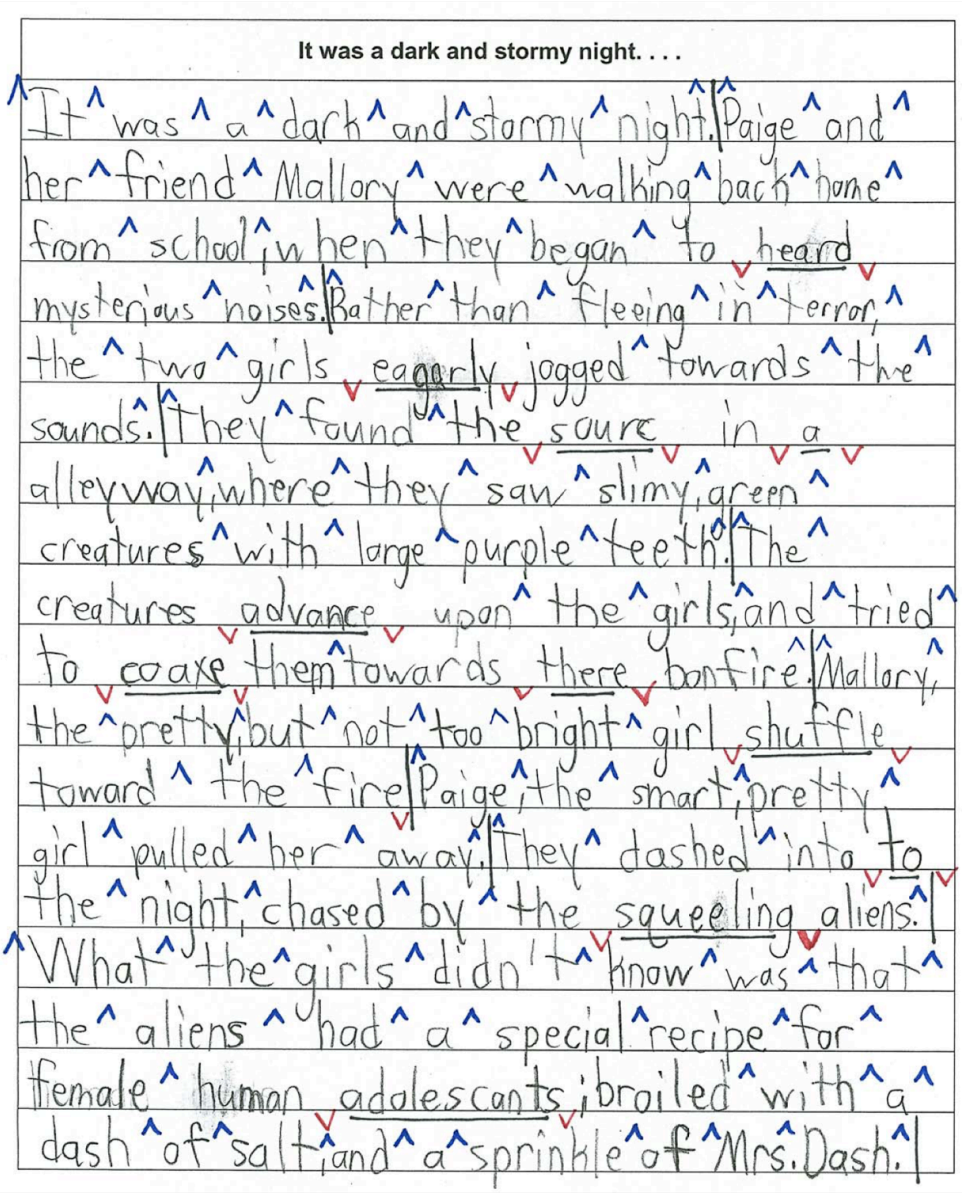
5. *One day I went to school but nobody was there except me…*

An important step with W-CBM is graphing the data; the visual representation helps both teachers and students monitor progress over time. To identify students who have, or are at risk for, writing difficulties, it is recommended that both rate of growth (slope) and level of performance be considered (i.e., compared to the average of the class).

The following Web-based resources are recommended as a starting point for readers interested in learning more about W-CBM:

Procedures for Scoring Writing Samples
http://www.progressmonitoring.org/pdf/RIPM_Writng_Scoring.pdf

Using CBM for Progress Monitoring in Written Expression and Spelling
http://www.studentprogress.org/summer_institute/2007/Written/Writing_Manual_2007.pdf



It was a dark and stormy night. . . .

It was a dark and stormy night. Paige and her friend Mallory were walking back home from school, when they began to heard mysterious noises. Rather than fleeing in terror, the two girls eagerly jogged towards the sounds. They found the soure in a alleyway, where they saw slimy, green creatures with large purple teeth. The creatures advance upon the girls, and tried to coaxe them towards there bonfire. Mallory, the pretty, but not too bright girl shuffle toward the fire. Paige, the smart, pretty girl pulled her away. They dashed into to the night, chased by the squeeling aliens. What the girls didn't know was that the aliens had a special recipe for female human adolescants; broiled with a dash of salt, and a sprinkle of Mrs. Dash.

FIGURE 4. Middle Grades Student's W-CBM Narrative Writing Sample

USING CIWS, THE SCORE FOR THIS PROBE WOULD BE: 92

([CWS = 115] – [IWS = 23] = 92 CIWS)

The explanation for each Incorrect Word Sequence (IWS) is as follows:

1. Incorrect tense (should be *hear*)
2. Incorrect spelling (should be *eagerly*)
3. Incorrect spelling (should be *source*)
4. Incorrect word choice (should be *an*)
5. Incorrect tense (should be *advanced*)
6. Incorrect spelling (should be *coax*)
7. Incorrect word choice (should be *there*)
8. Incorrect tense (should be *shuffled*)
9. Missing end punctuation (should have a *period after fire*)
10. Repeated phrase (*to* is not necessary)
11. Incorrect spelling (should be *squealing*)
12. Incorrect spelling (should be *adolescents*)

FIGURE 5. CIWS Scoring for Student Writing Sample

Practice 2: *Provide students with feedback about their writing.*

A long-term staple of writing instruction is for teachers to provide students with feedback about one or more aspects of their writing. Such feedback can range from written comments that identify writing strengths and aspects of a composition that need revision (and why), to observations on the student's progress in learning specific writing strategies, knowledge, and skills. Feedback can also include conferencing with students to determine what they are trying to accomplish, and providing them with supportive and constructive feedback about these efforts and the resulting written product.

It is important for middle grades teachers to remember that feedback should at once inspire and support students' development as writers. We next highlight several characteristics of feedback that are most likely to meet those important aims.[49, 50, 51, 52]

- Teacher feedback does not need to be given on everything students write, nor does it need to be extensive. For example, constructively highlighting a limited number of things a student needs to work on is more effective than identifying everything that could be improved.

- Clear and appropriate criteria should be the foundation for feedback, and students should be aware of these criteria before they begin writing. For example, Aida and Miguel's persuasive argument goals (described in Principle 2, Practice 1) could serve as the framework for feedback the teacher provides to each student.

- Feedback should be clear, specific, and explanatory, such as: *Laura, you might want to spend some time further developing your setting. As I read, I found myself wanting to know more about where and when the story took place.* Generic feedback (e.g., *Nice job*, *Revise*, or *Setting needs work*) is not perceived by students as helpful and is unlikely to promote improvement in their writing.

- Always include affirmation, reinforcement, and praise as part of feedback to students. When offering constructive criticism, be sure the tone is positive and encouraging. Provide comments that will help students think critically and creatively about possibilities for revision, rather than specifically directing or requiring a particular change. Thus, a teacher might write: *I think this idea is really interesting. Can you expand it so we better understand how it relates to the other parts of your text?*

- Offer feedback that helps students understand how their writing is experienced by the reader. Providing the reader's point of view can be achieved through the use of techniques such as providing personal reactions (e.g., *Wow! I was not expecting that to happen!* or *This section made me really understand a new aspect of your character*.), posing questions (e.g., *Did you intend for your reader to wonder if the protagonist was still alive? If so, it certainly worked with me!*), and offering suggestions (e.g., *In this paragraph, is there a way you can really emphasize how the experience made you feel? I think that would really help the reader understand what you went through*.).

- Ensure feedback is appropriate, given a student's current level of development and writing proficiency. Accordingly, teachers can ask themselves:

    - Will the student be able to understand and successfully respond to the comments I offer?

- If it is anticipated that a student might have difficulty with revisions, support and resources can be provided by including comments such as:

    - Why don't you sign up for a conference later this week and we'll work on this together?

    - Check your text book on p. 79 to see a couple of examples of this pattern.

    - Jamal has become really good at using dialogue in his writing and he said he'd be happy to show you some of the ways he does it. Why don't you talk with him and then come share what you learned with me?

- Provide students with feedback at multiple points during the composing process, not just after they submit the final draft. Feedback given during planning, drafting, and revising should target writing strategies, substantive text elements and qualities, and subject-matter content. Feedback related to writing conventions (e.g., spelling, punctuation, usage) and the overall appearance of the text (e.g., handwriting, spacing) is best left for the editing and publishing stages.

- Help students understand and appreciate that feedback is offered to help them become better writers, not just to improve their grade—which is what many middle grades students believe. Teachers can do this by focusing on students' effort and persistence, along with highlighting subsequent opportunities for learning and improvement. For instance, a teacher might comment:

    - I'm not sure this essay represents your best effort. Let's work together tomorrow to identify what to change to make something you are proud of.

- Create opportunities that increase the likelihood students will carefully read and use the feedback offered to them. For example, after handing back a draft with comments, teachers can have brief conversations with each student and pose questions, such as:
    - What did you think the strengths of your paper were?

    - Based on my feedback, what do you think I saw as the strengths?

    - What are your goals for the next draft?

- Another strategy is to have students attach an "Author Memo" when they return a revised version of their work. This memo should summarize how they responded to feedback.

Practice 3: *Teach students how to give one another feedback about their writing.*

When students give feedback to their peers on what they write and, in turn, receive feedback from their fellow students, it has a positive impact on writing performance.[49, 50, 51, 52] Peer feedback is also advantageous because it (a) provides another audience for student writing beyond the teacher, (b) helps students internalize the criteria for good writing, and (c) reduces the amount of feedback teachers need to provide.

Middle grades teachers have found that both peer partners and peer groups can be successful. The former has the advantage of being a bit more time efficient (students have to read and respond to the writing of only one other person), whereas the latter offers students a broader perspective and response to their writing. In some instances, teachers separate peer revision from peer editing to increase the likelihood that students will offer each other substantive feedback related to writing features and qualities (revising), rather than just commenting on surface-level issues, such as conventions and appearance (editing).

Research suggests that incorporating peer feedback into the writing process is most effective when teachers provide students with appropriate training in providing feedback and structure the peer feedback process. Examples of what middle grades students need to learn to successfully participate in and contribute to peer feedback experiences include providing a peer with helpful (i.e., specific and descriptive) feedback, offering recommendations in a non-judgmental way, accepting constructive criticism from others in appropriate ways, and

demonstrating the skills that are essential for all successful cooperative learning experiences (e.g., active listening, respecting confidentiality). Although training and structure are important for the success of peer feedback with students of all ages, they are particularly salient for middle grades students because of these students' heightened sensitivity to social interactions, strong desire for peer acceptance, and tendency to be self-conscious.

An example of a strategy to structure the feedback process is shown in Figure 6. During the first step, pairs of students provide each other with feedback targeting writing features and qualities (revising). During the second step, the focus shifts to writing conventions (editing). To help students provide meaningful feedback to their peers, specific criteria (e.g., a rubric, a set of goals, a series of prompting questions) are used in both steps. This strategy for peer editing is flexible and could be adapted by teachers to meet the unique needs of their students and the targeted writing task.

Some middle grades teachers find it beneficial to initially discuss and model the peer feedback process by sharing a piece of their own writing with students and facilitating a discussion about how a peer might review and respond to the text. Within that context, students can be guided to consider the kinds of feedback that would and would not be helpful to an author. Students might also generate sentence starters that can be used to help structure the feedback they provide to their peers:

- *When I read this part, I thought about…*
- *This sentence is really effective because…*
- *I was a bit confused by ___ because…*
- *I don't quite understand ___. Did you consider....?*

The teacher can also model appropriate ways to receive constructive criticism and manage emotions:

- *I worked really hard on that part, so it's disappointing that you didn't understand what I was trying to say. But, thanks for pointing it out. I'll see if I can make it better.*

Fishbowl observations[a] and role-play can also be used to develop students' understanding of how they can make the process successful.

Finally, teachers are likely to find peer feedback most effective when it is used in combination with instruction and strategies that target revision. If students do not know how to effectively revise a piece of text, they are unlikely to be able to offer meaningful feedback to another author, nor will they be able to respond to the suggestions provided by a peer.

[a] *Fishbowl observations consist of some students participating in role-play while others analyze and observe their behavior. Then there is a whole-group discussion about the observations of the participants and the observing students.*

Sample Peer Feedback Strategy	
Step 1: REVISING	**Step 2: EDITING**
• Listen carefully and follow along as the author reads aloud. • Tell the author what you liked about the paper. Remember to be specific and to explain why you liked something. • Switch authors and repeat the steps above. • Carefully reread the paper to yourself. • Use the assignment rubric to offer helpful comments and suggestions. Make notes on the draft. • Discuss your feedback with the author.	• Discuss the revisions you made. • Carefully reread the revised paper to yourself. • Use the editing questions to offer helpful comments and suggestions. Make notes on the draft. • Discuss your feedback with the author.

Source: Adapted from MacArthur, Schwartz, and Graham (1991)[53] *and Stoddard and MacArthur (1993).*[54]

FIGURE 6. Sample Peer Feedback Strategy

Practice 4: *Teach students how to assess the quality of their own writing.*

To become skilled writers students must develop the ability to accurately assess the strengths and weaknesses of their own writing in order to better direct how specific papers are revised, as well as set goals for aspects of their writing that are in need of more general improvement.[14, 37] Self-evaluation procedures range from teaching students to use a rubric to assess the merits of specific features of their writing (e.g., ideation, organization, voice, vocabulary, sentence formation, and conventions), to teaching specific strategies for evaluating a first draft of a paper for substantive (e.g., clarity) or mechanical (e.g., misspelled words) lapses, to teaching students how to detect mismatches between what they intended to say and what was written. Teaching such self-assessment procedures has the added benefit of helping students learn the characteristics of good writing while providing another avenue for writing feedback (albeit a personal one).

Although some middle grades students may already demonstrate proficiency with self-assessment, most need to be taught the purpose and process of evaluating their own writing. One way to help students develop the ability to reflect upon and critique their own writing is to pair self-assessment with self-recording—that is, recording the information learned as a result of self-evaluation.[17] Self-recording can be done in a variety of ways, such as marking a response on a rubric and/or visually representing data on a graph or chart. The method selected should be relatively quick and easy to use and be perceived by the student as acceptable and beneficial. What follows (Figure 7) is an example of how the goals established for a particular assignment (and in this case, also a particular student, as previously described in Principle 2, Practice 2) can be used as the basis for self-assessment and self-recording. The questionnaire focuses Aida's attention on comparing her writing with each of her goals and also serves to guide her subsequent revisions. Graphing the number of goals met before and after revision helps Aida see improvement over time (Figure 8).

As with teacher and peer feedback (Practices 2 and 3), students must be able to make meaningful revisions in response to information gleaned through self-evaluation. In other words, it would be doing Aida a disservice to have her evaluate and record her use of exciting, interesting, "come to life" words if she didn't know what they were or how to integrate them effectively into text.

An excellent Web-based resource for learning more about self-assessment and other forms of self-regulation (e.g., goal-setting, self-instructions, self-reinforcement) is http://cehs.unl.edu/secd/self-regulation/

Aida's Self-Evaluation Questionnaire		
Questions to Ask Myself	**YES** **Kudos to me!**	**NO** **Focus here during revision.**
Did I include an introduction that gives my position?		
Did I include at least three reasons that make sense and have details?	**R1:** **R2:** **R3:**	**R1:** **R2:** **R3:**
Did I include evidence and examples for each reason?	**R1:** **R2:** **R3:**	**R1:** **R2:** **R3:**
Did I include a possible argument against my position?		
Did I include a convincing conclusion?		
Did I use exciting, interesting, "come to life" words to make my argument more convincing?		
Total	**_____ out of 10**	**Summarize Revision Goals Below**
My revision goals:		

FIGURE 7. Sample Self-Evaluation Questionnaire

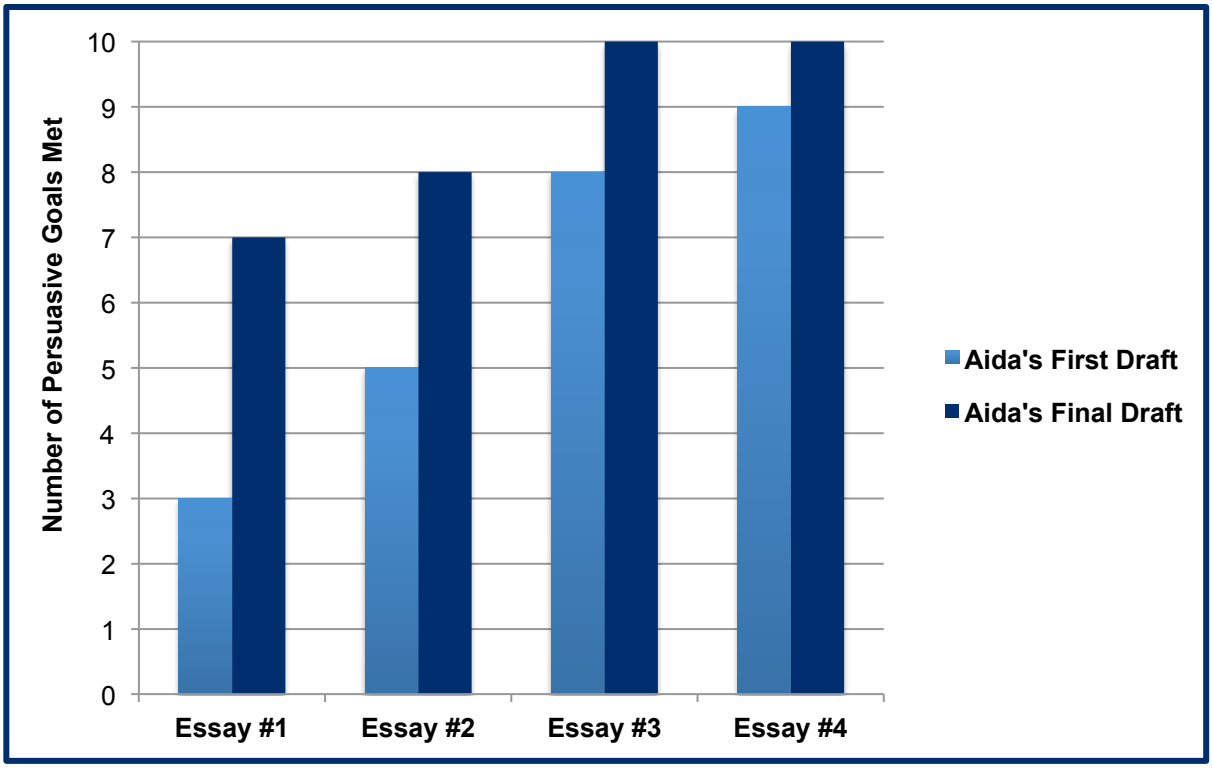


FIGURE 8. Sample Graph of Student Goals Met Before and After Revisions

Principle 5:

Provide extra assistance and instruction to students who experience difficulty learning to write.

Students who experience difficulty effectively using writing as a tool for learning, communication, and self-expression will require extra support to become effective and skilled writers. Schools need to develop procedures for identifying these students and providing them with explicit instruction in developing basic knowledge, strategies, and writing skills.

Practice 1: *Provide students with intensive and extra instruction to acquire the strategies, knowledge, and writing skills that still need to be mastered.*

Even when schools and teachers apply the most effective writing methods available, some students will nonetheless experience difficulty learning to write.[55] If these students are to become skilled writers who can use writing as an effective tool for learning, communication, and self-expression, they require extra instructional assistance to acquire essential writing strategies, skills, and knowledge. To provide effective instruction, schools must have methods in place for identifying students who need extra assistance, and for determining the type of extra assistance each student needs. Then, intensive instruction can be focused on the particular skills and strategies that require additional attention.[56]

Identify Struggling Writers.

The writing assessments described in Principle 4, Practice 1 can help educators identify students who have, or are at risk for developing, writing difficulties. For example, with W-CBM, a student's rate of growth (slope) and level of performance can be compared with the average slope and average level of performance for students in a particular class or grade-level.

Norm-referenced writing assessments can also be beneficial for identifying students who need extra assistance because these assessments allow educators to compare a student's level of writing proficiency to a normative sample. Norm-referenced tests help educators answer questions, such as the following:

1. Is the student's current level of writing achievement within the expected range for his or her current age and/or grade-level?
2. How does the student's writing proficiency compare with his or her achievement in other academic areas (e.g., reading, mathematics)?
3. How do the students' writing-related skills (e.g., spelling, grammar) compare with each other?[39]

Two examples of comprehensive norm-referenced tests that are commonly used with middle grades students are the *Woodcock-Johnson Tests of Achievement—Third Edition* (WJ-III) and the *Wechsler Individual Achievement Test—Third Edition* (WIAT-III).[57, 58] The WJ-III includes six subtests that target written language: Spelling, Writing Fluency, Writing Samples, Editing, Sounds of Spelling, and Punctuation and Capitalization. The WJ–III also includes a Handwriting Legibility Scale that can be used to analyze the handwriting a student produces in conjunction with the Writing Samples subtest, or any other written product. The WIAT–III includes three writing-related subtests that are appropriate for middle grades students: Spelling, Sentence Composition, and Essay Composition. Whereas the WJ–III and WIAT–III can be used to assess achievement in multiple academic areas, the *Test of Written Language—Fourth Edition* (TOWL-4) is a norm-referenced instrument designed specifically for the purpose of assessing various facets of written language.[59] The TOWL-4 includes seven subtests: Vocabulary, Spelling, Punctuation, Logical Sentences, Sentence Combining, Contextual Conventions, and Story Composition.

Diagnostic assessments that target a particular domain of writing can also be beneficial for identifying students who need extra assistance and for gathering information about a student's unique strengths and areas of need—which is essential to plan an appropriate intervention.[39] For

example, if a student is having difficulty with spelling, educators might elect to gather data with an assessment such as the *Spelling Performance Evaluation for Language and Literacy* (SPELL-2).[60] SPELL-2 is individually administered via a multimedia CD-ROM computer program. After a student completes the SPELL-2 assessment, the program generates a detailed report that summarizes the student's strengths and needs, suggests appropriate learning objectives, and identifies relevant word study lessons in the corresponding curriculum, SPELL–Links to Reading and Writing.

Readers interested in learning more about SPELL-2 are encouraged to see the descriptions and case studies presented in works by Apel, Masterson, and Hart and visit http://www.learningbydesign.com/.[61, 62]

Provide Appropriate Intervention.
Once a student's writing needs are identified, an appropriate evidence-based intervention must be selected and implemented. Although there are instances when struggling writers require support that is not generally used with typically developing writers (e.g., speech to text software), the majority of practices shown to be effective for most struggling writers are not radically different from those recommended for all middle grades students. To illustrate, there are practices that have a moderate or strong positive impact[63] with students who experience writing difficulties (i.e., struggling writers with and without learning disabilities), and among them were:

- Teach students strategies for planning, revising, and editing their compositions.
- Have students work cooperatively with other struggling writers to plan, draft, revise, and edit their compositions.
- Set clear and specific goals for what students are to accomplish in their writing.
- Use word processing and related software as a primary tool for writing.
- Teach text transcription skills (handwriting, spelling, and typing).

There is significant overlap between these recommendations and those presented in Principles 1–4. Students who struggle with writing in particular need instruction that is more intensive, explicit, systematic, and individualized.[64, 65] A large body of research documents that intensive, explicit, systematic, and individualized instruction has a strong positive impact on the quality of writing produced by all middle grades students. The effect is particularly robust for students who struggle with writing, including those with disabilities.

Self-Regulated Strategy Development (SRSD; described previously in Principle 2, Practice 2) is an evidence-based approach that was developed specifically to meet the needs of students who experience difficulty with writing.[17, 18, 20, 64, 66] Intensive, explicit, systematic, and individualized, SRSD instruction helps students gain relevant writing and genre knowledge; learn strategies that guide the basic steps in the writing process (e.g., planning, drafting, revising, and editing); learn strategies for accomplishing specific writing tasks (e.g., a personal narrative, a persuasive argument, an expository essay); learn procedures for regulating the writing process (e.g., goal-setting, self-monitoring, self-instructions, self-reinforcement); and develop positive attitudes towards writing. What follows is an example of how SRSD instruction could be used as a supplemental intervention to address the needs of middle grades students who struggle with writing.

PRACTICE 1 EXAMPLE APPLICATION: Writing Intervention with Self-Regulated Strategy Development

A team of eighth-grade teachers uses assessment results to determine that several students are experiencing significant difficulty revising their writing. In their content-area classes, the students receive feedback on their writing from their teachers and participate in peer revising groups (as described in Principle 4, Practices 2 and 3). However, an examination of students' revision attempts provides clear evidence that they are not responding successfully to feedback. Nearly all the changes they make target writing conventions—in other words, they are editing, not revising. At a grade-level team meeting, it is decided that the students will participate in a supplemental intervention to increase their knowledge of how writers can effectively revise their compositions (e.g., adding, deleting, and re-organizing text; expanding on ideas) and learn a strategy that will guide them through the process of revision.

The SRSD instructional model is used for the intervention, which consists of 30 minute sessions that occur twice a week in the school library. Instruction begins with the teacher leading a discussion about the ways authors meaningfully revise their work. Students are introduced to the strategy (represented by the mnemonic REVISE, shown in Figure 9), and the teacher interactively models its use several times. The students also learn how a word processor can be used to facilitate revision. The teacher then supports students while they practice using the strategy to guide their revision of content-area writing assignments. Because SRSD instruction is criterion-based, the intervention ends for each student when he or she is able to independently and successfully apply the strategy to revise compositions assigned by the content area teachers.

REVISE: A Strategy for Revising Text *Students are provided with two sets of cue cards (6 Evaluate cards and 4 Verbalize cards) that guide and prompt their use of the strategy. Prior to using the strategy, they establish one or two goals for themselves (e.g., add more details and examples so my paper is more convincing to the reader).*	
Read Your Essay	Read your essay aloud softly. Highlight places where you think changes should be made and ask yourself if you need more ideas. Use a caret ^ to indicate where you will add something.
Evaluate the Problems	Evaluate the problems. *Use the Evaluate Cards.* **1.** This doesn't sound quite right. **2.** Part of the essay is not in the right order. **3.** People may not understand what I mean. **4.** I am getting away from my main point. **5.** This is a weak or incomplete idea. **6.** The problem is _____.
Verbalize What You Will Do	Verbalize what you are going to do to fix the problems. *Use the Verbalize Cards.* • ADD: Include more information, examples, details, etc. • DELETE: Take something (a word, phrase, or sentence) out. • REWRITE: Say it (a word, phrase, or sentence) in a different way. • MOVE: Arrange information (a word, phrase, or sentence) in a different way.
Implement the Changes	Implement the changes.
Self-Check Your Goals	Self-check the goals you set for yourself. Make other revisions based on these goals.
End by Rereading and Making More Changes	End by rereading your revisions. Make any additional changes that will improve the writing.

Sources: De La Paz, Swanson, & Graham (1998)[67]; Harris et al. (2008).[17]

FIGURE 9. Sample Strategy for Revising Text

Practice 2: *Teach students how to use word processing programs and software that provide assistance for targeted writing strategies and skills.*

Some middle grades students continue to experience difficulty with specific aspects of writing (such as spelling, handwriting, planning, or evaluation), despite strong efforts by teachers and schools to teach these writing skills and processes. For these students, schools should teach students how to use word processing programs and software that provide students with assistance with these challenges.[35] For example, word prediction programs reduce the number of key strokes needed to write individual words, addressing the needs of students who experience continued difficulties with the motor aspects of typing. Planning software provides students with help in organizing their ideas for writing, whereas automated computer-scoring programs now provide feedback on what students write.

Using Word Processing Software With Students

Students need to be taught how to use word processing programs and software that provide them with specific assistance in carrying out targeted writing strategies and skills. This includes explaining the purpose of the program or software and how it works. Teachers should model how to apply a program or software and then provide guided practice until students can use it independently and effectively.

Practice 3: *Provide to students experiencing difficulties intensive and extra instruction in using writing as a tool to support content learning.*

While all writers benefit from using writing as a tool for learning, students who are experiencing difficulties learning to write often need extra instruction in how to use these tools effectively.[1, 2, 13, 68] Writing to learn strategies, such as note taking, summarizing, and analyzing/interpreting, are complex learning tools. Many less-skilled writers will need to be taught these writing procedures through a gradual-release model in which the technique is described, modeled (possibly repeatedly), and practiced on real learning tasks with assistance and feedback from the teachers until students can apply the model successfully and independently.[69] The Pathway Project provides an exemplary illustration of how this type of instruction can be used to successfully teach analytic writing skills to middle grades students who are English language learners.

Readers interested in learning more about the Pathway Project cognitive strategies approach to reading and writing instruction are encouraged to see the research published by Olson and colleagues and visit http://www.nwp.org/cs/public/print/resource/2487.[70, 71, 72, 73]

Principle 6:

Discontinue using practices that are NOT associated with improved outcomes for students.

Teachers and principals must make decisions about student learning and behavior each day. While it is preferable to rely on evidence-based practices when teaching writing, determining what constitutes evidence-based practice can be a confusing and difficult process. In addition, teachers may currently use teaching practices that are ineffective, such as the traditional approach to teaching grammar. With the traditional method, a grammar skill is defined and practiced in a decontextualized manner (e.g., selecting the right tense for a verb in a sentence from three options) or practices such as sentence diagramming are employed.[3, 13] There are, however, effective practices for improving student grammar in writing, such as contextualized grammar instruction with scaffolded authentic practice and sentence combining instruction (See Principle 2, Practice 3.).[74]

Practice 1: *Take stock of all of the instructional practices and models currently implemented and determine whether they are necessary and associated with improved outcomes for students.*

It is important to identify classroom practices and determine whether there is evidence to support them. Examining the results of published, empirical studies is the preferred way to determine whether a particular practice is validated by sound research. Because there is a relatively large—and growing—body of literature related to adolescent writing, reviewing all the available research would be a daunting and impractical endeavor. To make the process more efficient, educators are encouraged to first consult several recent meta-analyses related to writing. These offer a systematic and succinct summary of the literature and report the effectiveness (i.e., strength and consistency) of multiple practices.[3, 11, 13, 19, 25, 34, 37, 75, 76, 77]

What follows are other text and web-based resources that summarize relevant research and offer recommendations for practice.

Four recommended books that summarize high quality writing research and—based on that research—describe recommendations for classroom practice:

Applebee, A. N., & Langer, J. A. (2013). *Writing instruction that works. Proven methods for middle and high school classrooms.* New York, NY: Teachers College Press.[78]

Graham, S., MacArthur, C., & Fitzgerald, J. (2013). *Best practices in writing instruction* (2nd ed.). New York, NY: Guilford.[79]

MacArthur, C., Graham, S., & Fitzgerald, J. (2015). *Handbook of writing research* (2nd ed.). New York, NY: Guilford.[80]

Olson, C. B. (2010). *The reading/writing connection: Strategies for teaching and learning in the secondary classroom* (3rd ed.). New York, NY: Pearson.[81]

Two recommended journal articles that summarize research-based recommendations for writing instruction and assessment with students who experience difficulties with writing:

Olinghouse, N. G., & Santangelo, T. (2010). Assessing the writing of struggling learners. *Focus on Exceptional Children, 43*(4), 1-27.[39]

Santangelo, T., & Olinghouse, N. G. (2009). Effective instruction for students who have writing difficulties. *Focus on Exceptional Children, 42*(4), 1-20.[40]

Recommended websites for information about effective adolescent literacy practices:

1. What Works Clearinghouse: http://ies.ed.gov/ncee/wwc/
2. Best Evidence Encyclopedia: http://www.bestevidence.org/
3. Teaching LD Current Practice Alerts: http://teachingld.org/alerts
4. Center on Response to Intervention: http://www.rti4success.org/
5. The IRIS Center's Resource Locator: http://www.iris.peabody.vanderbilt.edu/resources.html
6. The Carnegie Council for Advancing Adolescent Literature: https://www.carnegie.org/about/our-history/past-programs-initiatives/#literacy
7. National Center for Learning Disabilities: http://www.ncld.org/
8. AdLit.org: All About Adolescent Literacy: http://www.adlit.org/
9. The National Council of the Teachers of English: http://www.ncte.org/

After determining there is adequate research evidence to support the use of a particular writing practice or model, an important second step is reviewing school-based data (e.g., results from state or national writing tests, W-CBM, other forms of assessment) to verify that the positive outcomes reported in the literature are being realized with the students in a particular middle grades setting. If they are not, it is essential to investigate why the discrepancy is occurring, make appropriate modifications, and monitor the impact of the changes. For example, there is considerable research showing SRSD produces meaningful improvements in middle grades students' writing. If a school adopted the SRSD model as part of its writing curriculum, but students were not showing the expected gains, questions such as the following might be considered:

- *Did teachers receive adequate professional development?*
- *Are appropriate strategies being selected and taught?*
- *Are the instructional stages being implemented with high fidelity?*

Finally, where there is an absence of published research supporting the efficacy of a writing practice currently being implemented, educators must use school-based data to systematically evaluate whether that practice results in positive outcomes. Moreover, because writing curriculum and instruction can have a differential effect with diverse populations (e.g., students with disabilities, English language learners, students with varying levels of writing proficiency), data should be disaggregated and carefully analyzed.[82]

Principle 7:

Improve teacher capacity to teach writing and use it as a tool for learning.

Many middle grades teachers are not adequately prepared to teach writing. The reasons for this range from teacher preparation programs that do not emphasize how to teach writing to a lack of in-service preparation by the school or district on writing instruction. Lack of preparation is especially problematic for teachers in science, social studies, and mathematics.[83] If middle grades students are to learn to write effectively and use writing as a tool to support learning of content material, their teachers must become more knowledgeable about effective writing practices.

Practice 1: *Provide ongoing in-service professional development to all teachers to increase their capacity to teach writing.*

Many teachers receive little to no preparation in college in how to teach writing to middle grades students.[83, 84] This lack of preparation is unnecessary as a variety of evidence-based practices for teaching writing have been identified.[3, 11, 13, 19, 25, 34, 37, 75, 76, 77] To ensure that teachers are familiar with effective writing practices, ongoing in-service preparation should be provided by the school or school district. School leaders should clarify expectations for school wide practice with regard to writing and provide in-service and support on these practices for all teachers in the school.

Consistent with the description and recommendation for professional development offered in the *Performance Management* section of this guide, professional development focused on writing should be intensive and ongoing, focused on the ways writing can be used to support content area learning and targeted at prioritized areas of need. One example of a model that meets these goals is the National Writing Project (NWP). The NWP consists of a 200+ sites located at colleges and universities across the United States. Among the professional development opportunities offered by the NWP are invitational summer institutes to train teacher-consultants to lead school-based improvement, on-site in-service programs, continuing education courses, and practitioner research initiatives.

Interested readers are encouraged to visit the NWP's website at http://www.nwp.org

Practice 2: *Have teachers create learning groups to share their best writing practices and work together to discover new ones.*

Teachers' personal experiences are an often-underused resource for increasing the capacity to teach writing. Teachers within and across disciplines should be encouraged to form groups to teach one another best writing practices and collaboratively improve classroom writing instruction and the use of writing to support student learning. Such groups can operate during the school year or the summer, and they can involve teachers from multiple schools. When teachers work together in this way, less experienced teachers benefit from the knowledge of more seasoned teachers.

Conclusion

The seven Writing and Writing Interventions principles are based on meta-analyses of writing intervention research. This includes three meta-analyses of experimental and quasi-experimental writing intervention studies conducted by Graham and colleagues for the Carnegie Corporation of New York: *Writing Next*,[13] *Writing to Read*,[5] and *Informing Writing*.[28] The principles are also supported by nineteen other meta-analytic reviews that focus on particular types of research (e.g., single subject designs), particular practices (e.g., writing to learn, word processing, formative assessment), and/or particular groups of students (e.g., students with learning disabilities).[1, 2, 3, 4, 11, 14, 18, 19, 25, 33, 34, 35, 36, 37, 38, 64, 75, 76, 77] The carefully selected, high-quality individual studies cited in this chapter offer additional support for the principles and practices and complement the meta-analytic findings. Consequently, each of the seven principles are supported by relatively strong evidence involving multiple empirical studies, even though there are no studies examining the impact of applying the recommended principles in unison. Research examining the combined effects of the principles is needed, and future studies should investigate this issue.

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Writing And Writing Interventions

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Mathematics and Mathematics Interventions

Mathematics includes knowledge and skills that are used to access science, technology, engineering, and mathematics applications and careers and that improve reasoning and analytic thinking. Given the importance of algebra for success in high school and beyond, many states have moved to increase student expectations in this area.[1] Thirty-four states now require Algebra I or its equivalent for graduation.[1] Despite the effort to increase expectations, achievement data indicate students continue to struggle to attain proficiency, especially those with disabilities and difficulties. As a result, the National Mathematics Advisory Panel[3] convened, and a careful examination of the research evaluating the effectiveness of instructional practices for struggling learners was launched. The following nine key principles reflect research in mathematics education synthesized by the Panel and the Institute of Education Sciences.[2, 3, 4, 5]

Principle 1:

Establish school wide practices for enhancing mathematics understanding within relevant content area instruction.

Mathematics is a foundational tool that can be used across many content areas (e.g., integrated science, social studies, health). Doing so provides students with important opportunities to practice and apply mathematical tools and skills. Therefore, it is important that content area teachers consider the mathematics relevant to their discipline and expect students to be able to use their mathematical knowledge and skills to better understand and communicate what they are learning in other content domains.

Practice 1: *Encourage students to apply their understanding of mathematics concepts and procedures to draw conclusions and propose solutions about history, science, social studies, economics, and other content areas.*

In many cases, content area teachers will find instances in which mathematics can be used to summarize, illustrate, explain, or analyze information. Reference materials, textbooks, and primary source documents frequently include related information that can be displayed graphically; summarized using statistics, including measures of central tendency; and/or interpreted to draw conclusions and make predictions.

Practice 2: *Ask students to analyze events and phenomena from a quantitative perspective and use their analyses to develop arguments and provide justifications.*

Many content disciplines (e.g., history, science, mathematics) are taught in an isolated fashion but are related in important ways. For example, many historical events can be described as a human response to natural phenomena (science) and can be summarized and analyzed using data (mathematics). While reading and writing help with acquisition and comprehension, mathematics and quantitative reasoning (e.g., economic analysis, historical trends, epidemiological analysis) can help with interpretation and broadening perspectives.

PRACTICE 1 EXAMPLE APPLICATION: Apply Mathematics in Science

A physical science teacher will find daily opportunities for students to collect and analyze data based on their observations. For example, students may be studying objects, such as marbles or toy cars, moving at a fixed distance. They can record the time each object takes to move the distance and from that information determine the speed as a function of distance and time. These observations can be organized in tables and graphics, and conclusions can be drawn about the objects' features that result in differences in speed. This type of mathematics application can be expanded further to include proportional reasoning by having students examine how the speed changes with varying distances.

PRACTICE 2 EXAMPLE APPLICATION: Quantitative Reasoning in Social Studies

Quantitative reasoning can be used in teaching social studies by having students examine sources regarding population changes, technological advances, and timelines to draw conclusions about the factors (e.g., warfare, migration, etc.) that contributed to specific historic events. For example, a social studies teacher might introduce students to the spice trade. Students today are likely to struggle to understand why spices were so valuable in the fourteenth century. However, when presented with data comparing the value of today's common spices with their value to Europeans in the 1300s, students will quickly understand why people risked their lives to search for new markets. Students can use their quantitative reasoning to explore predictions for similar risks people take today.

Principle 2:

Use a universal screener to identify students at risk for mathematics difficulties and to determine interventions to provide these at-risk students. Monitor the development of mathematics knowledge and skills of identified students.[4]

The universal screener[a] ensures that schools can identify students who will likely need support beyond the typical core instruction provided in the general education classroom. Subsequent progress monitoring should be used to continue to track the effectiveness of interventions. The frequency of progress monitoring should reflect the level of support needed, with more vigilant monitoring used for students with greater needs.

Practice 1: *Identify a system for screening and progress monitoring that prioritizes content and skills necessary for subsequent mathematics development.*

The content of the universal screener should reflect mathematics knowledge and skills essential for grade-level proficiency. The specific content selected should relate to the domain in which potential risk is being evaluated. For example, if the assessment system is screening for potential risk in algebra and algebra readiness skills and knowledge, the universal screener should target content knowledge and skills related to algebra and algebra readiness.

Practice 2: *Select a cut score for screening that balances the need to help the most at-risk students with the resources available.*

In a universal screening system, cut scores are used to identify ranges of scores along the distribution that might indicate risk status. For example, three cut-scores could be established to identify students who might be at risk for failure and the significance of the risk. In this model, the distribution of scores could be divided into three categories to indicate students who might have minimal risk of failure, students who have some risk of failure, and students who have significant risk of failure.

A number of factors should be considered in determining the appropriate cut score used in screening. Ensuring that children who need additional support are accurately identified and that resources are available to provide the additional support are two essential considerations.

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a A universal screening is a quick assessment that allows for repeated testing of all students on skills of interest. This kind of screening is used to determine the efficacy of the curriculum and instruction and the level of student proficiency in a specific area (e.g., mathematics, reading). Then school administrators and teachers can analyze the data by group, by individual student, and by specific skill to make decisions about interventions to improve student outcomes. These screeners are typically given to all students at three time points in a year.

Principle 3:

Help students recognize number systems and expand their understanding beyond whole numbers to integers and rational numbers. Use number lines as a central representational tool in teaching this and other rational number concepts.[4, 6]

There is growing understanding that students' preparation for success in algebra lies in their proficiency with numeracy.[6] Numeracy, often called "number sense," refers to a "child's fluidity and flexibility with numbers, the sense of what numbers mean, and an ability to perform mental mathematics and to look at the world and make comparisons."[7] Numeracy includes students' conceptual understanding of number systems and of the properties and operations that govern lawful application during problem solving. Numeracy also relates to students' ability to extend generalizations about one number system to another. By generalizing, students can apply their knowledge of concrete numbers to algebraic reasoning.

Practice 1: *Use measurement activities and number lines to help students understand that fractions and decimals are numbers and share number properties.[8]*

Using number lines is an effective way to illustrate that fractions and decimals have magnitude similar to whole numbers. Measuring objects using number lines with fractions demonstrates to students that fractions have magnitude. For example, the following illustration (Figure 1) shows how a simple number line with fractions can be used to measure a common object.

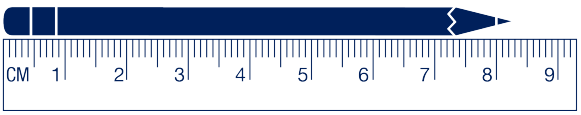


FIGURE 1. Measuring common objects with fractions

Practice 2: *Provide opportunities for students to locate and compare fractions and decimals on number lines.*

By accurately placing fractions and decimals on a number line, students learn to make relative comparisons. Comparing fractions and decimals facilitates students' understanding of the role magnitude plays in increasing precision of measurement.[9] Relative comparisons, as such, also help students justify the reasonability of their answers. A sample number line for comparing fractions is provided in Figure 2 within the *Practice 2 Example Application.*

Practice 3: *Use number lines to improve students' understanding of fraction equivalence, fraction density (the concept that there are an infinite number of fractions between any two fractions), and negative fractions.*

Comparing and extending number lines uses visual representations to develop students' understanding of equivalent fractions. Placing increasingly smaller fractions on a number line illustrates a unique characteristic of rational numbers: They can represent increasingly precise values between whole numbers. A sample number line is provided in Figure 3.

PRACTICE 2 EXAMPLE APPLICATION: Sample Lesson for Comparing Fractions

Objectives: Students will be able to connect fractions to a number line and use a number line to identify equivalent fractions.

Instruction: Compare fractions on the number lines such as those in Figure 2. Select one pair of equivalent fractions (e.g., $\frac{3}{4}$ and $\frac{6}{8}$) and explain to students that these fractions are equivalent because you can multiply the numerator and denominator of one fraction by the same number (e.g., 2) to get the other fraction. Point out that when fractions are equivalent, they are located on the same place on the number line.

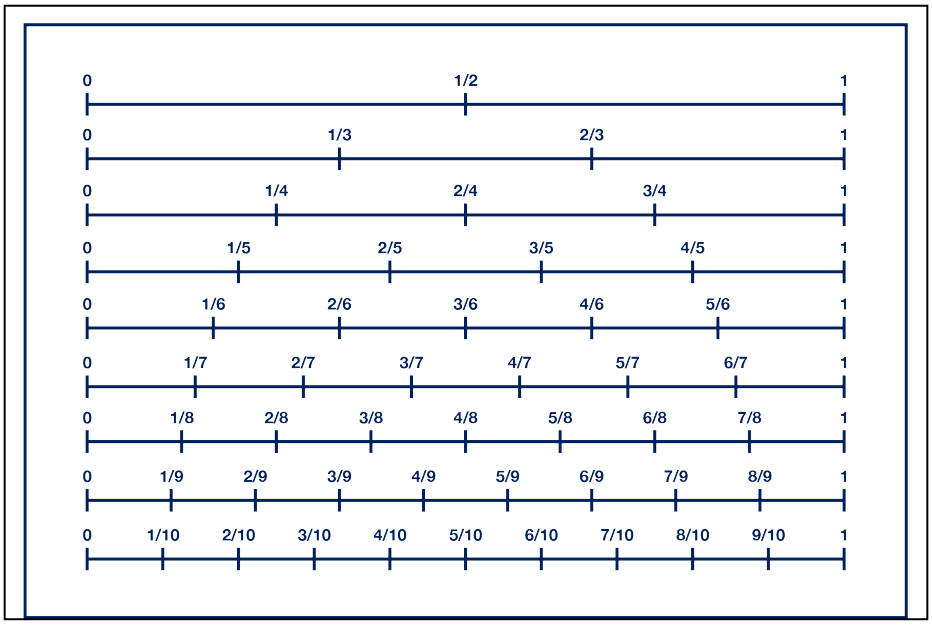


FIGURE 2. Number Line Representations for Comparing Fractions

Practice 4: *Explain that fractions can be represented as common fractions, decimals, and percentages, and develop students' ability to translate among these forms.*

Students must learn that numbers are representations of values and that these representations can be expressed in different forms. Students need to be able to transition between these different forms efficiently. For example, students should understand that

$\frac{8}{10}$ = 0.80 = 80%

Just as number lines can be used to develop an understanding of equivalent fractions, they can also be used to demonstrate equivalence among representations of rational numbers. For example, the illustration in Figure 3 demonstrates how a number line can be used to emphasize equivalence between fractional representations and decimal representations, such as

0.4 = $\frac{4}{10}$ = $\frac{2}{5}$ 0.4 < $\frac{1}{2}$

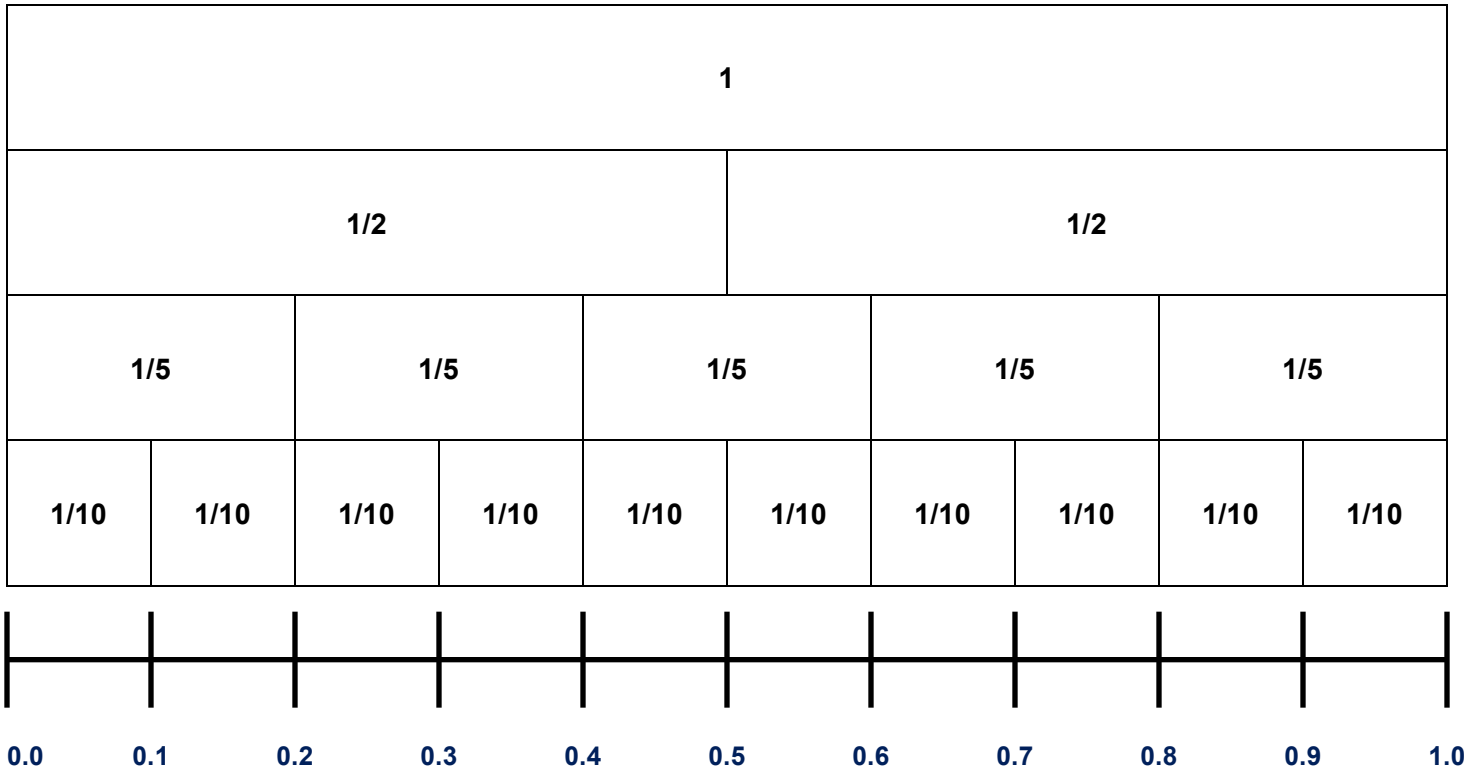


FIGURE 3. Number Line Representation of Equivalent Fractions

Principle 4:

Develop students' conceptual understanding of mathematics and provide ample opportunities to improve procedural fluency.[3, 4, 10]

Ultimately, the goal is to improve students' abilities to apply mathematics knowledge to solve problems. Evidence suggests that overall outcomes are improved when students develop conceptual understanding of mathematics in addition to procedural fluency.[11] A balanced approach to instruction helps students understand why procedures for computations with fractions and other number systems and algebraic expressions make sense. For students receiving intervention, specific amounts of allocated time should be spent on improving procedural fluency.

Practice 1: *Use area models, number lines, and other visual representations to improve students' understanding of formal computational procedures.*

Students' application of mathematical procedures should be based on a strong conceptual foundation. This foundation can be built by demonstrating mathematical procedures through physical and representational models. For example, the illustration in Figure 4 can be used to help students understand the need to find a common denominator when adding fractions.

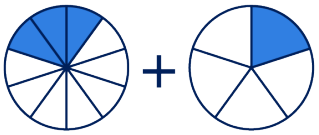


FIGURE 4. Representation for Finding Common Denominators

Resources for implementing this practice can be found at the Middle School Matters Institute website:

- **Visual Representations Toolkit** https://greatmiddleschools.org/toolkits/math/visual-representations/

Practice 2: *Use meaningful fact practice activities for students lacking a strong foundation in math facts.*

Practice, not drill, is necessary to learn any new skill. This is especially true in mathematics. To aid in computational efficiency, students need comprehensive knowledge and recall of math facts for addition, subtraction, multiplication, and division. To begin, teachers should assess the fluency of students. If students experience difficulty with fluency, teachers should explicitly teach early numeracy and operations concepts. Daily practice activities, conducted for a brief amount of time, can improve math fact fluency. Technology can also be used for math fact practice.

Practice 3: *Address common misconceptions regarding computational procedures.*

Students' errors can provide valuable information to guide instruction. Often, students generally understand the procedure but inadvertently make mistakes when executing computations. However, in some instances, these mistakes represent persistent misconceptions or misapplications. Through his research, Ashlock identified three basic categories of computational errors: (a) wrong operation, in which the student uses an inappropriate operation to solve a problem, (b) computational error, in which the student uses the appropriate operation but makes an error involving basic number facts, and (c) defective algorithm, in which the student uses the appropriate operation but makes a non-number fact error in one or more steps of the operation.[12] Defective algorithms often result when students over-generalize procedures without relying on standard algorithms or a foundational understanding of the procedure, as is illustrated in the *Practice 3 Example Application*. These misconceptions need to be addressed in instruction to prevent chronic errors.

In terms of algorithms, students should learn a standard algorithm for each distinct type of computation. A standard algorithm is a set of steps that will work for a type of computation problem (e.g., multi-digit multiplication). Teachers can expose students to other strategies to provide different options for approaching novel problems.[1] However, students should not be forced to demonstrate fluency with all strategies.

Practice 4: *Present real-world contexts with plausible numbers for problems.*

Students often find solving problems that are situated in real-world examples to be motivating and relevant to their experiences. Teachers should take care, however, to use real-world contexts that are meaningful while still maintaining the intended mathematical ideas.[13]

PRACTICE 3 EXAMPLE APPLICATION: Proportional Reasoning

In proportional reasoning, teachers commonly teach students the strategy of cross-multiplying. Students become proficient at the procedure but do not understand why cross multiplication is a lawful, efficient way to solve a problem involving a proportion.

$$\frac{2}{3} = \frac{x}{6}$$

When cross-multiplied, this is $3x = 12, \text{and } x = 4.$

However, if students understand that equivalent fractions represent the same magnitude and, by definition, they can multiply both sides by the same number and the fractions remain equivalent. Therefore, if students multiply both sides by the product of the denominators the result is:

$$\frac{2}{3}(18) = \frac{x}{6}(18)$$

When simplified, this is:

$$\frac{36}{3} = \frac{18x}{6}$$

$12 = 3x$, and $x = 4$

Cross multiplication is efficient, but unless students understand the underlying mathematics, it could lead to errors and possible misconceptions.

Principle 5:

Provide explicit and systematic instruction during instruction and intervention.[3]

In core instruction, teachers often engage students in learning about a new topic or procedure by having them explore the mathematics teachers believe will be involved. Due to the large teacher-student ratio, the guidance during practice, the corrective feedback during instruction, and the review may be insufficient to help struggling students make progress toward expected outcomes. Students having difficulty with mathematics require explicit and systematic instruction that includes modeling concepts, procedures, and proficient problem solving processes; verbalizing thought processes; guided practice; corrective feedback; and frequent cumulative review.[14]

Practice 1: *Include explicit teacher or peer modeling and demonstrate key concepts and skills.*

Students who struggle in mathematics need an instructional model from a teacher or a more proficient peer that is clearly communicated and that illustrates the steps in the mathematical procedure so the learner can repeat them successfully.[15, 16] The teacher should use precise language to present clear models, and these models should include examples to illustrate concepts and demonstrate procedures. By verbalizing the thinking involved in completing the model, the teacher helps students develop the critical thinking skills and the vocabulary that will guide them through similar problems in the future.[17] As students develop understanding, instruction will expand to a broader range of examples that may increase in complexity.

Resources for implementing this practice can be found at the Middle School Matters Institute website:

- **Peer-Mediated Instruction Toolkit**
  https://greatmiddleschools.org/toolkits/math/peer-mediated-instruction/

Practice 2: *Include worked examples of key concepts and skills.*[1]

A teacher's or peer's modeling may include worked examples that the teacher or peer analyzes and discusses in the context of the step-by-step algorithm or process used to work the examples. For example, in the *Practice 1 Example Application*, a teacher could present the work (written in the left column) and use the think-aloud presented in the right column.

Practice 3: *Gradually transition from teacher-modeled problem solving to student-directed problem solving.*

Students need to develop independent problem solving strategies. It is helpful to provide students with a framework for problem solving, such as a step-by-step checklist or mnemonic that reminds students of the problem-solving process. This process can involve coaching and prompting that decreases as students become more proficient.

PRACTICE 1 EXAMPLE APPLICATION: Proportional Reasoning Using a Think-Aloud Strategy

In the following example, a teacher provides students with explicit instruction on how to change a mixed number to an equivalent fraction.

Example	Teacher Think Aloud
$2\frac{2}{3}$	How can I convert this to another fraction with the same value?
$= 1 + 1 + \frac{2}{3}$	First we convert the whole number 2 to two ones. How can I add whole numbers to the fraction? I have to also make them fractions.
$= \frac{3}{3} + \frac{3}{3} + \frac{2}{3}$	Next, we convert the whole numbers to fractions with the same denominator as two thirds.
$= \frac{8}{3}$	Can I add these fractions? Yes, they have the same denominator, so I add the numerators. 3 plus 3 plus 2 equals 8. The answer is eight thirds.

PRACTICE 3 EXAMPLE APPLICATION: Transitioning from Teacher-Modeled Problem Solving to Student-Directed Problem Solving

In the example below, the teacher uses questions to guide students thinking through a proportional reasoning problem:

For every 30 students at school, 10 bring their lunch. If there are 700 students in the school, how many total students bring their lunch to the cafeteria?

- Let's highlight the key information. What two quantities are being compared? Highlight those two numbers.
- From this situation, can you write a proportion comparing two ratios? Why would it be important to include the units that are being compared? (To make sure that the proportion is comparing the same ratios)
- What is this problem asking? (How many students bring their lunch to the cafeteria if there are 700 students in the school?)
- Now, let's plan how to solve this problem. What quantities am I comparing? (Number of students bringing lunch to the cafeteria and total number of students)
- What do I know? (10 out of 30 students bring their lunch; there are 700 students in the school.)
- What quantities go together? (10 students bring their lunch for every 30 students; x students bring their and 700 total students in the school.)
- What am I looking for? (The number of students who bring their lunch out of 700 total students)
- How would I set this up?

$$\frac{\text{students eat in cafeteria}}{\text{total students}} = \frac{\text{students eat in cafeteria}}{\text{total students}}$$

Practice 4: *Include opportunities for students to talk aloud about the skills, knowledge, or problem-solving procedures they are learning.*

Encouraging students to verbalize the procedures for problem-solving and their rationale for each step will increase awareness of their thinking. This verbalization may initially need to be modeled by the teacher or a peer.[16, 17] (See the *Practice 4 Example Application*)

Practice 5: *Provide immediate and corrective feedback with opportunities for students to correct errors.*

Struggling learners are often unaware of their mistakes. Immediate and corrective feedback clarifies their understanding and reinforces accuracy. In the following example, a student is using multiplication to find equivalent fractions. (See the *Practice 5 Example Application*)

Practice 6: *Include sufficient, distributed, and cumulative practice and review.*

Many struggling learners need sufficient practice and review to develop mastery. Often, students remember more when they are exposed to the new information on two occasions (instead of just one) and when there is time between those two occasions.[18] This practice is called *delayed review*.[19] In addition, by distributing types of problems across assignments, students can experience overlearning of these topics or skills, and students learn to discriminate among operations and strategies.[20] An example would be to include a few review problems on homework and classwork each night for a few weeks and then once a week after that. This practice is associated with improved retention.

PRACTICE 4 EXAMPLE APPLICATION: Encouraging Students to Talk About their Thinking

Situation

You buy 2 packages of pencils for $4. How much would it cost to buy 12 packages?

Teacher: I see that you use different ways to find the answer. Mark, can you tell us how you solved the problem?

Mark: Sure. I knew that if I could figure how much 1 package costs, then I could multiply it by 12 to get the cost of 12 packages. You can buy 2 packages for $4, so you know 1 package is $2. So, I can multiply $2 by 12 to get $24 for 12 packages.

Teacher: Mark, how did you find out that 1 package is $2?

Mark: Oh, since 2 packages was $4, I divided $4 by 2, to get the cost of 1 package, $2.

Teacher: Okay, and do you remember what we called it when we found the cost of 1 package?

Mark: The unit rate?

Teacher: Yes! The unit rate is the cost for one package.

PRACTICE 5 EXAMPLE APPLICATION: Immediate and Corrective Feedback

Example of Reva's work

$$\frac{2}{3}(2) = \frac{4}{3}(2) = \frac{8}{3}(2) = \frac{16}{3}$$

Teacher: Reva, explain how you found these equivalent fractions and how you know they represent the same magnitude.

Reva: Well, I multiplied each one by the same number, 2, to get the next fraction.

Teacher: What is the only number that we can use as a multiplier to get an equivalent fraction?

Reva: 1.

Teacher: That's right. Right now you are multiplying each fraction by $\frac{2}{1}$.

What would you have to multiply each fraction by to get an equivalent fraction and still use 2 as the multiplier in your numerator?

Reva: $\frac{2}{2}$?

Teacher: That's right! Let's go back and use $\frac{2}{2}$.

Principle 6:

Instruction should include strategies for solving word and algebra problems that are based on common underlying structures.[17]

For Word Problems:
Common word-problem structures have growing support in literature and have been successfully employed in mathematics instruction for some time.[21] Intervention programs are increasingly focusing on these structures in an effort to help students identify the relevant information in a problem. From this information provided in the structure, students can systematically identify an effective approach to solving the problem.

Typical word-problem structures for additive word problems include combine, compare, and change. Structures to solve multiplicative word problems include equal groups, comparisons, and combinations. While these problem structures should be a focus of instruction in the elementary grades, middle grades students may need a review and additional practice solving word problems with these structures. Often, at the middle grades, students solve multi-step additive and multiplicative word problems that include whole or rational numbers and feature information from tables, charts, or graphs.

In the middle grades, a common problem structure relates to ratios. Problems that involve ratios generally include two problems that are being compared and ask the student to use that comparison to find a missing number.[22] The problem below illustrates this:

Problem:
Each time Jim inserts 2 tokens into the gumball machine he gets 3 gumballs. How many gumballs would he get if he puts in 20 tokens?

The numbers being compared are 2 tokens and 3 gumballs. The missing number is the number of gumballs he would receive if he put in 20 tokens. This problem structure is common to ratio problems. After students work several problems of this type and learn how to identify the common structure, they are able to categorize this as a ratio problem.

For Algebra:
Teaching students to focus on problem "structure helps students make connections among problems, solution strategies, and representations that may initially appear different but are actually mathematically similar."[1]

For example, the equations $2x + 8 = 14$, $2(x + 1) + 8 = 14$, and $2(3x + 4) + 8 = 14$ may look different, but to solve each equation 2 is multiplied by a quantity and 8 is added to sum to 14.

Practice 1: *Include systematic instruction on the structural connections between known, familiar, and novel word problems.*

Teach an organizational strategy for setting up and solving problems. Then, help students identify underlying structures of problems across a range of examples to ensure generalization. Students who receive instruction in finding the underlying structures in problems are able to solve problems more efficiently because they have a schema for the problem and do not have to relearn how to set it up with each new problem they encounter. They also are better able to recognize meaningful features of a problem, such as the following example problem, and do not rely on key words or superficial features of the context.

Examine the *Practice 1 Example Application*. Students who have been explicitly taught how to identify the features of a ratio problem rather than seeing its superficial structure will see that there are two compared numbers in each of these problems. However, in the third problem, students would look at the question and would determine that it is a problem that doesn't require a ratio.

PRACTICE 1 EXAMPLE APPLICATION: Proportional Reasoning Word Problems

Problem: Felicity rides her bike at a rate of 4 miles per hour. How many hours will it take her to ride 22 miles at a constant rate?

Problem: The gas mileage for Elijah's car is 22 miles per gallon. How many gallons of gas would it take to drive 432 miles at a constant rate?

Problem: Each time Susan's mom deposits $100 in Susan's savings account, she also deposits $50 in Susan's brother's account. How much money does she have to deposit each time?

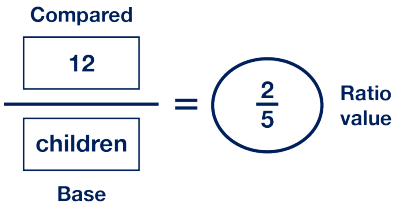
Practice 2: *Teach common problem types and their structures, as well as how to categorize and select appropriate solution methods for each problem type.*

Proficiency with problem solving depends on the student's ability to see common problem types and connect them to viable solutions. Struggling students need to receive explicit instruction on organizing information presented in word problems, on common problem types, and appropriate solutions. [23, 21]

Resources for implementing this practice can be found at the Middle School Matters Institute website:

- **Schema-Based Instruction Toolkit:** https://greatmiddleschools.org/toolkits/math/schema-based-instruction/

PRACTICE 2 EXAMPLE APPLICATION: Teaching Common Problem Types—Ratio Problems

Problem	Teacher Language
The ratio of the number of girls to the total number of children in Ms. Robinson's class is 2:5. The number of girls in the class is 12. How many children are in the class?	**Step 1:** Find the problem type. • Read and retell problem to understand it. • Ask if the problem is similar or different from other problems. • Is this a ratio problem?
Ratio Problem  	**Step 2:** Organize the problem. • The number of girls in the class is 12. • The ratio of the number of girls to the total number of children in Ms. Robinson's class is 2:5.
$\frac{12\ girls}{d\ children} = \frac{2}{5}$	**Step 3:** Plan to solve the problem.
$\frac{12\ girls(5d)}{d\ children} = \frac{2\ (5d)}{5}$ $60\ = 2d$ $30\ children = d$	**Step 4:** Solve the problem. • Multiply both sides by the product of the denominators. • Simplify and multiply both sides. • Divide both sides by 2.

Principle 7:

For students who struggle in mathematics, instruction and intervention materials should include opportunities to work with representations of mathematical ideas.[24] Teachers should be proficient in the use of these representations.

As discussed in Principle 4, Practice 1, evidence suggests that using visual representations during instruction can improve students' conceptual understanding and procedural fluency. For students who are struggling, research indicates that using visual representations during lessons may improve students' overall outcomes in mathematics, pre-algebra proficiency, problem-solving skills, and procedural fluency. Many mathematics textbooks provide little information about using visual representations, so teachers should use explicit instruction to introduce and explain all visual representations to students.[25] Through carefully sequenced instruction, visual representations appear to help students transition from concrete models of mathematical ideas to abstract mathematical representations. Moreover, students can use visual representations to develop strategies for translating word problems into abstract numerical statements.

Practice 1: *Employ visual representations to model mathematical concepts.*

Foundational understanding of mathematics depends on seeing its application to physical and visual models. Intervention instruction should incorporate concrete and visual (i.e., semi-concrete) representations of mathematical concepts to develop foundational knowledge. Instruction, however, should use representations as a support for mathematics learning rather than a focus of the lesson.[26]

Practice 2: *Explicitly link a visual representation or model with the abstract mathematical symbol or concept.*

To learn to interpret and comprehend abstract mathematics, students must see and understand how a visual representation can be translated into abstract numbers and number sentences. See Figures 1, 2, 3, and 4 for visual representations related to fractions. See the *Practice 2 Example Application* on the following page for an example related to algebra.

Practice 3: *Use consistent language across similar representations.*

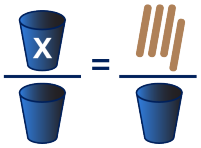
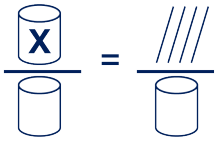
Students will be better able to perceive similarities across representations if language is consistent and precise. For example, interventionists should use the same mathematically precise language when using concrete models, visual representations, and abstract mathematical notation. (See *Practice 3 Example Application*)

Resources for implementing this practice can be found online:

- **Visual Representations Toolkit**
  https://greatmiddleschools.org/toolkits/math/visual-representations/

PRACTICE 2 EXAMPLE APPLICATION: Matched Concrete, Visual, and Abstract Representations

3 + X = 7

Solving the Equation with Concrete Manipulatives (Cups and Sticks)	Solving the Equation with Visual Representations of Cups and Sticks	Solving the Equation with Abstract Symbols
A 		$3 + 1X = 7$
B 		$\begin{array}{rr} -3 & -3 \\ \hline \end{array}$
C 		$\frac{1X}{1} = \frac{4}{1}$
D		
E 		$X = 4$

Concrete Steps
A. 3 sticks plus one group of X equals 7 sticks
B. Subtract 3 sticks from each side of the equation
C. The equation now reads as one group of X equals 4 sticks
D. Divide each side of the equation by one group
E. One group of X is equal to four sticks (i.e., 1X/group = 4 sticks/group; 1X = 4 sticks)

PRACTICE 3 EXAMPLE APPLICATION: Consistent and Precise Language

In the *Practice 2 Example Application,* you can see how solving for an unknown number in an equation is displayed using concrete examples, visual representations, and numerals. In all three forms, the language should be consistent.

For example, in Step A, the teacher and students can say: “Three sticks plus one group of some number of sticks is seven sticks.”

Step B: “Subtract three sticks from both sides.”

Step C: “One group of unknown number sticks is four sticks.”

Step D: “Divide each side of the equation by one group.”

Step E: “The unknown number sticks is four sticks.”

Principle 8:

Establish a school wide plan to identify and improve teachers' mathematical and pedagogical content knowledge.

Mathematical content knowledge refers to teachers' understanding of the precise mathematics that underlie the content being taught. "Teachers must know in detail the mathematical content they are responsible for teaching and its connections to other important mathematics, both prior to and beyond the level they are assigned to teach."[3] Teachers with a deep understanding of mathematics possess a conceptual understanding of the entire elementary and middle grades mathematics curriculum that goes beyond simply being able to execute the algorithms.[27]

Pedagogical content knowledge refers to the integration of mathematical content knowledge with knowledge of students, learning, and the influences of pedagogy on instructional practice.[28] Pedagogical content knowledge should inform the design and delivery of instruction, as well as interactions with students during the learning process. Specifically, teachers' pedagogical content knowledge is elicited when reasoning through mathematical explanations that arise in response to students' questions, analyzing textbooks and instructional aids for appropriateness and/or alignment with instructional objectives, and creating instructional materials, such as tests and homework exercises.

The research demonstrating the impact of teachers' mathematical and pedagogical content knowledge is limited and often is not designed to evaluate causal relationships. However, numerous mathematics education researchers and mathematicians hypothesize that teachers' mathematical and pedagogical content knowledge is highly correlated with student achievement.[3] Wu notes the impact on student engagement stating, "teachers who can make transparent what they are talking about (cf. definitions and precision), can explain what they ask students to learn (cf. reasoning and coherence), and can explain why students should learn it (cf. purposefulness) have a much better chance of opening up a dialogue with their students and inspiring them to participate in the doing of mathematics" (p. 6-7). [29]

Practice 1: *Assess teachers' needs in relation to mathematics content knowledge and mathematics pedagogical content knowledge across content areas.*

To accurately target professional development, mathematics teachers' depth and breadth of mathematical and pedagogical content knowledge should be assessed.[30] Because mathematical reasoning should be integrated across relevant content areas, professional development may be needed for teachers responsible for other content areas. Needs assessment tools are available to assist administrators, instructional coaches, or other teacher leaders in gathering this information (See Center on Instruction in Mathematics: http://www.centeroninstruction.org/identifying-professional-development-needs-in-mathematics-a-planning-tool-for-grades-3-7---second-edition).

A needs assessment can include teachers' self-reflection of their strengths and limitations, as well as an objective test of their knowledge and skills. Results from the needs assessment should be used to tailor professional development to support individual teacher's needs and to structure and inform the work of teacher professional learning communities.

PRACTICE 1 EXAMPLE APPLICATION: Steps for Conducting a Needs Assessment

1. Determine the purpose of the needs assessment and how the results will be used.
2. Determine who will administer the assessment, when, and how data will be analyzed and reported.
3. Identify the population of teachers who will take the needs assessment. Different populations might need differently designed needs assessments.
4. Identify what type of information is needed (e.g., self-perception, objective data, program evaluation).
5. Design the data collection instrument to capture the type of information needed.
6. Collect and organize data.
7. Analyze data based on the purpose of the needs assessment.
8. Use results of the needs assessment to inform design of professional development.

RESOURCE FOR EVALUATING QUALITY AND IMPACT OF PROFESSIONAL DEVELOPMENT

The Council for Chief State School Officers (CCSSO) analyzed evaluations of teacher professional development programs in mathematics and science. In conducting their review, they evaluated programs' effects on student outcomes, teacher content knowledge, and instructional practices. Additionally, they considered the quality of the research design and instruments used in making the evaluation. Reports published by objective organizations such as CCSSO provide a good resource for gathering information about the quality and potential impact of professional development programs.

Practice 2: *Select and implement high-quality professional development that acknowledges different teachers' needs.*

To effectively change teachers' practices, professional development opportunities should align with the standards and expectations proposed by Learning Forward (formerly the National Staff Development Council: http://www.learningforward.org) for staff development. Most importantly, professional development should be targeted to support individual teachers' needs. Because it takes time to build and grow professional knowledge, professional development should be delivered over time. Moreover, effective professional development should be situated within a collaborative environment, often within learning communities or by encouraging discourse among colleagues. All professional development opportunities should be evaluated for alignment with these expectations prior to implementation.

Practice 3: *Improve teachers' knowledge and understanding of making practice decisions based on research evidence and student data.*

A culture of using evidence to guide instructional decisions should focus on two types of activities.

First, student performance data should be systematically gathered at points before, during, and after instruction to guide instructional and programmatic decisions. Teachers and administrators should understand the types of data needed, how to collect and analyze data, and how to make decisions and communicate regarding the results.

Second, research- and evidence-based solutions should be integrated into teachers' and administrators' practices. Teachers and administrators should engage in ongoing professional development by reading research literature on mathematics instruction and interventions and by considering how these practices can be implemented within the local context. Moreover, administrators should cultivate a school climate that allows for experimentation and implementation of evidence-based practices in a supportive environment. Administrators and colleagues can work with teachers to support fidelity of implementation of research- and evidence-based practices.

Principle 9:

Discontinue using practices that are NOT associated with improved outcomes for students and teachers.

For students who are struggling in mathematics, it is essential that teachers employ practices that are supported by research. Fortunately, there are a number of resources available that describe and exemplify these practices. What follows are two recommended resources:

IES Practice Guide, *Assisting students struggling with mathematics: Response to Intervention (RtI) for elementary and middle grades.*[4]
http://ies.ed.gov/ncee/wwc/pdf/practice_guides/rti_math_pg_042109.pdf

What Works Clearinghouse (Identifies research on programs as opposed to practices):
http://ies.ed.gov/ncee/wwc/

Practice 1: *Examine the evidentiary bases of practices currently used in teaching mathematics and identify and eliminate practices that are contraindicated by existing evidence.*

There is a growing body of evidence regarding effective practices for teaching mathematics in middle grades. Research has been summarized on specific topics including instruction on fractions[6] and teaching struggling learners in mathematics.[4] While these documents represent important strides in knowledge about how best to provide instruction in middle grades mathematics for different types of students, even the document authors acknowledge that sufficient evidence to answer many important questions is lacking. For example, in the IES practice guide on struggling learners, it is recommended that instruction include motivational strategies for students who are receiving additional intervention in mathematics. However, there is little research available to support this recommendation. Rather, this recommendation comes primarily from the opinion of experts based on findings and theories in related areas or indirect evidence.

It is important that teachers and school leaders understand the current state of the evidence on mathematics instruction and how to use the evidence to examine their practices. Furthermore, it is very important that, in understanding the available evidence, teachers understand what is not known. It is also important for teachers to understand that in many cases, the available evidence focuses on elementary schools. However, in the absence of more substantial evidence, it is wise to consider this evidence and how it might relate to middle grades students.

For example, the use of manipulatives to teach mathematical concepts receives a lot of attention. Many online sources, print articles, and textbooks recommend the use of concrete objects to help students understand how mathematical ideas apply in the real world. These concrete objects (e.g., fraction bars, algebra tiles, abacus) are referred to as manipulatives because it is believed that students benefit from hands-on manipulation of these objects in developing their understanding of how mathematics works. The majority of research supporting manipulatives has been with students in the elementary grades; however, the research base related to the use of manipulatives to support mathematics learning in the middle grades is emerging.[31] Therefore, there are many questions that research has not yet answered, such as:

- How long do students need to manipulate these objects before they are ready to move to visual representations?
- If students already demonstrate understanding of a concept, do they need to go back to using the manipulatives to ensure they are not moving procedurally without sufficient foundational understanding?
- Which manipulatives help develop strong conceptual skill in each mathematical content area?

While awaiting more research across more mathematical content areas to address these and other questions, teachers should use their professional judgment on the necessity of hands-on activities and when they are most appropriately used in the classroom. Teachers should take this opportunity to conduct their own research using manipulatives. They can collect and analyze data to determine what is best for their students.

Practice 2: *Monitor student learning formally and informally and use trend data to determine whether and how to adjust current practices.*

Research summaries, such as those referenced above, provide answers to questions about the effectiveness of practices in particular contexts. Therefore, regular adjustments to instruction will be necessary. Decisions to make adjustments should be informed by multiple sources of student data. Decisions can be made at multiple levels: program, classroom, or student level. For example, based on grade-level data derived from state tests, a school may determine that a particular instructional program is not working for their students. A particular teacher may find that, based on periodic assessments of students' performance on a particular topic, additional support is needed for a group of students in the classroom in order for them to make sufficient progress.

Finally, progress monitoring with a single student or a small group of students may reveal that instructional adjustments need to be made to ensure that they learn a particular concept or skill or develop fluency with a particular procedure. For at-risk students, teachers should graph progress-monitoring data to determine whether these students are making adequate progress within their current mathematics program. Adequate progress may be determined by comparing the student's slope (i.e., trend in growth) to normative slope data or by comparing to a benchmark score.[5] If students do not demonstrate adequate progress, teachers should make instructional adaptations or changes. Continued progress monitoring will allow teachers to understand whether such adaptations and changes are beneficial for the student.

PRACTICE 2 EXAMPLE APPLICATION: Using Informal Data from Analyzing Student Work to Guide Instruction

A teacher has introduced equivalent fractions and has assigned a few practice examples for students to complete in groups. The group work requires students to determine whether two fractions are equivalent and to justify their answer. Each group successfully completes the assignment and appears to understand equivalent fractions. However, after reviewing their independent work the following day, the teacher notices a small group of students do not seem to understand that equivalent fractions, by definition, represent the same magnitude. Though the fractions have a different numerator and denominator, they are equivalent. Often, the students' equivalent fractions have different numerators but the same denominator. Based on this classroom data, the teacher makes the decision to use group work time to reteach the concept of equivalent fractions to this small group of students.

Conclusion

Mathematics is widely recognized as an important factor in furthering educational attainment and improving job market potential. A strong basis of mathematical education allows countries to develop the human capital needed to make scientific and technological advancements.[3] The principles and practices described in this section were derived from several sources including practice guides provided by the Institute of Education Sciences, meta-analyses in the research literature, and the report from the National Mathematics Advisory Panel (NMAP; 2008). Despite the importance of mathematics in everyday lives and to students' future academic success, many questions about how to teach mathematics effectively to the broadest range of students in the middle grades remain unanswered. Many of the principles and practices included in this section are supported by rigorous research. In instances such as Principles 1 and 2, where less rigorous research is available, principles and practices are based more on professional experience and clinical observations in schools. In addition, several areas that are currently considered important to mathematics learning have very little support in the research literature but warrant further investigation. For example, teacher knowledge of mathematics and how to teach mathematics are undoubtedly important to student achievement. Yet, only emerging evidence exists to support schools' efforts to provide professional development.

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Cognitive Science and Advanced Reasoning

Advanced reasoning and critical thinking skills typically undergo rapid expansion during adolescence and are refined in complexity and maturity throughout adulthood. Adolescence is an optimal, yet vulnerable, stage of cognitive development of higher-order thinking, reasoning, and problem solving. American adolescents are falling behind students in other developed countries in acquiring crucial advanced reasoning skills. The middle grades are referred to as a transitional black hole in education: The child moves out of the supportive and engaging learning environment of elementary school and into an environment with increased personal choices, with greater risk for failure, dropping out, and developing some form of addictive behavior.

Teachers can implement cognitive and reasoning principles to promote learning across all content areas in the middle grades. The cognitive principles of learning are based on reports from (a) the National Academy of Sciences,[1] (b) a practice guide for teachers by the Institute of Education Sciences in the U.S. Department of Education on *Organizing Instruction and Study to Improve Student Learning*,[2] (c) and a joint initiative between the Association of Psychological Sciences and the American Psychological Association on Lifelong Learning at Work and at Home.[3] The recommendations here reflect the wisdom of these reports, which are based on scientific evidence, rather than being consensus opinions of experts. What follows are seven key principles and related practices from this research.

Principle 1:

Distribute presentation, practice, and testing over time.

It is more effective to distribute the presentation of materials, practice, and tests over time than to block the learning experiences in a short time span.[4, 5, 6, 7, 8, 9] Teachers can promote delayed re-exposure to the material through homework assignments, in-class reviews, quizzes, and other instructional exercises. Tests or challenges can help promote distributed learning experiences and slow forgetting.[6, 10,11,12, 13, 14]

Practice 1: *Present material at different points in time in different contexts.*

Teachers can present the same or similar material at different times throughout a course. Presenting the same idea in different contexts is particularly helpful in allowing students to understand it from multiple perspectives.

Practice 2: *Test or challenge students frequently.*

Teachers should give frequent tests, quizzes, or assignments to force the student to regularly focus on the material and to distribute the practice of these skills to improve learning and retention. Instead of always labeling these "tests," teachers can call them "challenges" to foster motivation.

Practice 3: *Use cumulative tests.*

Teachers give cumulative tests because this practice encourages students to restudy earlier course material and thereby distribute their practice.[2] Students benefit more from repeated testing when they expect a cumulative final exam than when they do not expect a final exam.[15]

PRACTICE 1 EXAMPLE APPLICATION: Presenting Material Across Multiple Contexts

Teachers could present many contexts for students to learn about the Great Irish Potato Famine that last from 1845 to 1852:

- Learning about the history of Ireland
- Learning about fungus infections in crops
- Learning how a problem in one country can influence other countries
- Learning how a disease spreads in a population over time, including an exponential formula

PRACTICE 2 EXAMPLE APPLICATION: Game Playing

Educational games can motivate students while also testing knowledge of facts or difficult concepts. A well-designed game can both challenge students and frequently expose them to material.

It is important that the game design be built on principles of learning science. Most commercial games are not designed for learning but rather for entertainment. Teachers should examine evidence provided by game designers on the impact of the game on learning. If they are uncertain about the quality of the data, they should solicit advice from researchers at reputable universities and organizations and from school districts.

Principle 2:

Ground ideas in active, engaging experiences.

Concepts need to be grounded in activities that require students to actively engage in experience that relates to a real-life application of the content.[16, 17, 18, 19] Learners benefit from visualizing a picture of the concept, manipulating its parts and aspects, and observing how it functions over time, particularly in real-life contexts. Experiential learning is important when there is a need for precision of ideas and communication, particularly when content is first introduced, and it is beneficial to integrate experiential representations with more abstract representations.[20, 21, 22] Stories have concrete characters, objects, spatial layouts, and activities that bear some similarity to everyday experiences so they can be used to facilitate understanding and memory.[18, 20, 21, 22]

Practice 1: *Present visual depictions of core concepts and ideas.*

Teachers should present pictures, diagrams, graphs, and other visual depictions of the core concepts in the curriculum. Students have trouble learning abstract notions if they are not grounded in concrete representations. Whenever an abstract notion is presented, it needs to be accompanied by a supporting visual image.

Practice 2: *Encourage students to manipulate aspects of core concepts.*

Students acquire an embodied representation of core concepts when they can manipulate parts and entities and observe the consequences. Whenever a student performs an action accurately, it is likely that the student has mastered the concept. Mastery is entirely uncertain in the absence of student action.[22]

Practice 3: *Capture content in stories.*

Teachers should weave essential concepts into stories with concrete agents, spatial settings, objects, parts of objects, and organized action sequences. Stories can bring abstract content to life.[23, 24, 25] For example, telling a good story is a better way to help students understand history than asking them to memorize a list of dates, locations, and events. Science teachers can tell stories of how researchers discovered new theories or put a theory into practice.

PRACTICE 2 EXAMPLE APPLICATION: Hands-On Student Activities

Science labs provide an excellent opportunity for students to get a hands-on experience with science laws and concepts. Dropping objects of different weights or mass from a building to illustrate Newton's laws is an obvious example of how hands-on experience can teach an important concept.

Another example in mathematics is the activity of graphing data that students collect, such as the number of hours spent studying over time or the amount of algae in water samples in different locations in a city.

Computer environments with interactive simulation are an excellent way of learning about complex systems. Students can manipulate parameters and see what happens in simulations, and they can learn about difficult concepts, such as causal propagation, trade-offs between variables, and managing limited resources.

Principle 3:

Provide timely, qualitative feedback on students' learning activities.

Feedback helps learners tune their knowledge representations, skills, and strategies to include relevant and useful content.[26, 27, 28, 29, 30, 31, 32] The feedback can be supplied by people, computers, or constraints of the world. The feedback may identify and correct errors and misconceptions (errors of commission) or help fill missing information (errors of omission). The optimal timing of the feedback varies for different tasks. Immediate feedback supports correct information, prevents elaboration of incorrect information, and helps students acquire skills of self-regulated learning; however, it does have the potential to interrupt organized activities.[27, 29] Teachers should provide feedback on complex material that qualitatively explains correct and incorrect information, as opposed to merely flagging that an answer is incorrect or giving the student an overall score.[27, 28, 29, 30] A large amount of negative feedback may cause students to disengage because of feelings of low self-esteem and self-efficacy.

Practice 1: *Give students timely and accurate feedback on their performance.*

Teachers should provide accurate, timely feedback about students' ideas, answers, test items, solutions, writing, performances, and other tasks. Computer programs can provide immediate, accurate feedback to students on the answers, solutions, and essays they generate, whereas it may take a few minutes to a few weeks to receive answers from teachers.[30] However, computer-generated feedback may be less meaningful to students because it is less personal.

Practice 2: *Include qualitative explanations in feedback for complex material.*

Teachers should explain why answers are correct or incorrect rather than merely giving numerical scores or positive/negative feedback. Qualitative explanations state why an answer is right or wrong. The characteristics of a good explanation include:

- Identifying the elements in an answer that are problematic or particularly good (e.g., This statement is false.)
- Providing steps in a logical way or giving causal justification for the feedback (e.g., This word is incorrect because ___.)
- Contrasting a faulty piece of information with a correct piece of information (e.g., The numbers should decrease rather than increase because ___.)

Practice 3: *Adjust negative feedback to what the student can emotionally handle.*

Teachers should not provide students with a large amount of negative feedback, which can lead students to tune out. This can be accomplished by assigning easier tasks or by withholding feedback about unimportant errors.

PRINCIPLE 3 EXAMPLE APPLICATION: Providing Just Enough Challenge

Problems in a mathematics text are often scaled on difficulty, such as easy, medium, or difficult.

A student might get discouraged when assigned a large number of difficult problems that he or she answers incorrectly, resulting in negative feedback. To prevent boredom and discouragement, the teacher might assign an easier problem but say to the student, “Try this problem. It may be a challenge, but I bet you can handle it!” When the student readily solves the problem and receives positive feedback, his or her confidence, self-esteem, and self-efficacy increase.

Other students might get bored when not challenged. These students need to be assigned more difficult problems to work on.

There is a *zone of challenge* for most students according to the Goldilocks principle,[29] where problems or texts are not too easy, not too difficult, but just right. Computers can calibrate this level by tracking the performance of each student and scaling materials based on difficulty.

Principle 4:

Encourage the learner to generate content.

Students should be encouraged to actively generate language, content, solutions to problems, and reasoning rather than passively processing the new material.[33,34, 35, 36,37] It is not surprising that tutors learn more than tutees in peer tutoring because tutors are often more engaged with the material, while tutees are passive recipients of it.[38, 39, 40] Free recall or essay tests that provide minimal cues often produce better learning than recognition tests and multiple choice tests that require only that a student recognize correct answers. Outlining, integrating, and synthesizing information produces better learning than rereading materials or other more passive strategies. *Writing and Writing Interventions* describes ways to improve students' writing skills and support the active generation of information. Some computer programs provide immediate feedback on writing; however, it may not be as effective as a teacher's feedback when writing needs to be precise and make subtle discriminations.

Practice 1: *Assign tasks that require writing or other forms of generation.*

Teachers should assign tasks that require students to generate ideas, write, perform actions, solve problems, and reason. Students should not merely be passive recipients of information.[41]

Practice 2: *Arrange for students to teach other students.*

Teachers should set up peer teaching or tutoring that requires the student teacher/tutor to actively generate content. All students should have the opportunity to serve in the role of a teacher/tutor.[40, 42]

PRACTICE 2 EXAMPLE APPLICATION: Students Helping Students Activities

Teachers can use different ways to encourage students to tutor their peers and thereby benefit from active generation of information:

1. Pair students and have them take turns teaching topics to each other.

2. Present a difficult problem to the class and ask students to raise their hand as soon as they solve it. The first student to raise his or her hand presents the solution to the rest of the class.

3. Use the jigsaw method, whereby students are divided into groups and are asked to solve a problem. Each group member is given a particular piece of the solution that the other group members need to learn about. In this activity, students teach one another information in service of a concrete goal.

4. Ask groups of students to write justifications for their positions, and then have each student vote for a particular position on a controversial issue (e.g., how to solve world overpopulation, how to minimize global warming).

Principle 5:

Select challenging tasks that require explanations, reasoning, and problem solving.

Learning is facilitated when students need to construct explanations during the course of grasping difficult concepts or solving problems through reasoning.[35, 43, 44, 45, 46] Explanations consist of causal analyses of events, logical justifications of claims, and rationales for actions. Explanations are elicited by deep questions, such as *why, how, what-if* and *what-if-not*, as opposed to shallow questions that require the learner to simply fill in missing words, such as *who, what, where,* and *when*.[43] Training students to ask deep questions facilitates comprehension of material from text, classroom lectures, and electronic media.[47, 48] One method of stimulating explanations, reasoning, and deep questions is to present challenges, obstacles to goals, contradictions, scenario breakdowns, and difficult decisions that place the learner in cognitive disequilibrium.[48] Such "desirable difficulties" slow down initial learning, but promote long-term retention and transfer.[48, 49]

Practice 1: *Assign tasks that require explanation-based reasoning.*

Teachers should assign challenging tasks that require the students to explain their reasoning. The *Reading and Reading Interventions* section of this document provides different techniques to promote explanation-based reasoning. Types of explanation-based reasoning include:

- **Cause-effect:** Understanding how one action or event can cause another.
- **Problem-solution:** Defining the problem (or dilemma), explaining potential causes or background context of importance, identifying all possible solutions, and selecting an optimal solution based on context, resources, etc.
- **Claim-evidence:** Making a claim, a potential answer to a question or a problem, using evidence (data or other evidence) to support it, and providing an oral or written justification of how the evidence supports the claim.
- **Claims-logical conclusion:** Reviewing claims and evidence at detailed levels, leading to claim justification; then investigating processes to determine whether sufficient evidence exists at the aggregate level to support each particular claim or group of claims and to draw a logical conclusion.

Practice 2: *Ask students deep questions and train students to ask deep questions.*

Teachers ask deep questions, such as *why, how, what-if, what-if-not,* and *so-what*, rather than shallow questions such as *who, what, when,* and *where*. These teacher questions encourage the construction of explanations. If encouraged to do so, students will ask deeper questions and achieve deeper standards of comprehension. What follows is an illustration of using a question taxonomy.[48, 49]

Practice 3: *Present desirable difficulties that place the student in cognitive disequilibrium.*

Teachers should present challenges that involve obstacles to goals, contradictions, system breakdowns, trade-offs, anomalies, and other types of desirable difficulties. The resulting cognitive disequilibrium will stimulate deep questions, explanations, reasoning, and problem solving.

PRACTICE 2 EXAMPLE APPLICATION: Using a Question Taxonomy

Students can be explicitly instructed in the types of questions that lead to deeper standards of comprehension. Questions vary in depth and also how much information the student needs to provide in an answer:

1. **Verification.** Is X true or false? Did an event occur? Does a state exist?
2. **Disjunctive**. Is X, Y, or Z the case?
3. **Concept completion**. Who? What? When? Where?
4. **Example**. What is an example or instance of a category?
5. **Feature specification**. What qualitative properties does entity X have?
6. **Quantification**. What is the value of a quantitative variable? How much? How many?
7. **Definition**. What does X mean?
8. **Comparison.** How is X similar to Y? How is X different from Y?
9. **Interpretation**. What concept or claim can be inferred from a pattern of data?
10. **Causal antecedent.** What state or event causally led to an event or state? Why did an event occur? Why does a state exist? How did an event occur? How did a state come to exist?
11. **Causal consequence**. What are the consequences of an event or state? What if X occurred? What if X did not occur?
12. **Goal orientation.** What are the motives or goals behind an agent's action? Why did an agent do some action?
13. **Instrumental/procedural**. What plan or instrument allows an agent to accomplish a goal? How did an agent do some action?
14. **Enablement**. What object or resource allows an agent to accomplish a goal?
15. **Expectation.** Why didn't an expected event occur? Why doesn't some expected state exist?
16. **Judgmental**. What value does the answerer place on an idea or advice? What do you think of X? How would you rate X?

PRACTICE 3 EXAMPLE APPLICATION: Using Counterintuitive Facts to Stimulate Student Thinking

Students are often fascinated, confused, or sometimes even disturbed by facts that clash with their knowledge or beliefs. Examples of counterintuitive facts are that whales are mammals rather than fish, that violent crimes are decreasing in the United States, and that setting fires in forests sometimes helps the ecology.

Cognitive disequilibrium is experienced, and students try to restore clarity (equilibrium). They want to know how and why and to receive explanations. It is good to challenge students with counterintuitive facts, particularly ones that illustrate important material. Teachers are encouraged to:

- Identify facts that conflict with students' beliefs.
- Ask students to defend positions that are different from what they believe (as is done in formal debates).
- Ask students to explain the fact or why an event occurred.
- Ask students to find counterintuitive facts in different media and to verify that the facts are accurate by accessing reliable sources.

Principle 6:

Design curricula, tasks, and tests in different contexts, media, and practical applications.

Knowledge, skills, and strategies acquired across multiple and varied contexts are better generalized and applied flexibly across a range of tasks and situations.[50, 51, 52, 53, 54] Information is encoded and better remembered when it is delivered in multiple modes (such as verbal and pictorial), sensory modalities (such as auditory and visual), or media (such as computers and lectures) than when delivered in only a single mode, modality, or medium.[52, 53, 54, 55] Cognitive flexibility increases when there are multiple viewpoints and perspectives about a phenomenon[55, 56, 57] because multiple layers of knowledge interconnect facts, rules, skills, procedures, plans, and deep conceptual principles. Cognitive complexity and multiple viewpoints are helpful when learners face transfer tasks that have unique complexities that cannot be anticipated proactively. There are benefits in connecting and interweaving both abstract and concrete representations of problems in the domains of mathematics, science, and technology. [20, 57, 58, 59] These research- and evidence-based practices are described as follows.

Practice 1: *Vary the context and applications of tasks and problems.*

Teachers should assign tasks and problems in different contexts and practical applications. This variability gives students opportunities to apply knowledge and skills to new situations.[54]

Practice 2: *Present learning materials through multiple media.*

Teachers can combine graphics with text, graphics with spoken descriptions, speech sounds with printed words, and other combinations of modalities to vary how they present materials. Graphic depictions with spoken descriptions are particularly effective for subject matters in science and technology.

Practice 3: *Encourage students to construct ideas from multiple points of view and different perspectives.*

Teachers should encourage students to assess claims from different points of view, using different empirical evidence and including both pros and cons. A singular monolithic mindset does not support cognitive flexibility and variability in representations. An example of how to encourage students to construct ideas from multiple viewpoints is to have them justify a position that is opposite to what they believe in a debate.

PRACTICE 3 EXAMPLE APPLICATION: Multiple Viewpoints for Examining Chemical Reactions

In chemistry, students are often fascinated by the role of catalysts in chemical reactions. Students can explore the dynamics of a particular chemical reaction from multiple viewpoints, such as:

- An animation with the molecules before, during, and after the presence of the catalyst
- A graph that plots the presence of different chemicals as functions of time
- A mathematical formula that captures a diffusion process over time
- A chemist pouring chemicals together and presenting the catalyst

Principle 7:

Promote self-regulated learning.

Children and adults have very limited metacognition[46, 60, 61] (i.e., knowledge or judgments of memory, comprehension, learning, planning, problem solving, and decision processes). In fact, most adults are not good at calibrating their own comprehension of text and at planning, selecting, monitoring, and evaluating their strategies of self-regulated learning.[46, 60, 61,62] Therefore, teachers need to provide explicit training, modeling, and guided practice before students can acquire adequate strategies of comprehension, critical thinking, meta-comprehension, and self-regulated learning. These skills can be acquired and applied in a learning environment that allows students to have knowledge and control over their own mastery of knowledge, skills, and strategies.[46, 63] These research- and evidence-based practices are described in more detail as follows.

Practice 1: *Train students on metacognition and strategies for self-regulated learning.*

Explicit instruction is often needed for acquiring abstract cognitive content and strategies. Teachers should use well-designed, explicit instruction that is structured, scaffolded, and intensive in different contexts and practical applications.

Practice 2: *Provide students with an open learning environment.*

Open learning environments allow students to take responsibility for their learning by selecting resources to learn more about a topic, gathering and manipulating data to understand the problem, and working with peers. Teachers should provide individual students with fine-grained feedback about their mastery of different aspects of the learning. Students should then use the feedback as a guide to select and work on mastering different knowledge, skills, and strategies. By taking the initiative to fill in gaps in learning, students acquire self-regulated learning skills.

PRACTICE 1 EXAMPLE APPLICATION: Teaching Students Metacognitive and Self-Regulating Learning Strategies

There are many commercial books and programs on how to study and manage time, and these are often helpful. Researchers have also identified a number of metacognitive and self-regulated learning strategies that help with time management. These strategies guide students on setting goals, formulating plans to achieve goals, monitoring progress on goals, revising goals after receiving feedback, applying relevant learning strategies, and reflecting on learning activities to improve the goal-setting process. A list of these strategies, along with definitions, is an important start in helping students manage their own time; however, application of the strategies takes considerable time and feedback.

Students are generally not very good at comprehension calibration, the ability to evaluate how well they comprehend material. The common problem is that low comprehenders believe they understand material when they do not. Fast ways for them to evaluate their level of understanding are asking them to paraphrase, summarize, or think aloud about the text's meaning. Poor learners quickly discover that they do not understand because they have trouble generating content in the verbal protocols. Therefore, requiring students to give feedback about content allows them to learn how to accurately calibrate their own comprehension of material.

Conclusion

The principles and practices informed by research in this section can be applied to all content areas in middle grades education. For example, physical education teachers can use these strategies to help students retain information, such as the rules of sports and different sports strategies. More importantly, these principles and practices can provide students with study skills they can use with the more rigorous coursework of high school, where they may experience final exams for the first time. Therefore, the more these principles and practices can be adopted and implemented school wide, the more proficient students will become in their use. Middle grades students will then have the skills they need to succeed in high school, postsecondary education, and future careers.

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