ENGAGING IN COGNITIVELY COMPLEX TASKS

CLASSROOM TECHNIQUES TO HELP STUDENTS GENERATE & TEST HYPOTHESES ACROSS DISCIPLINES
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CLASSROOM TECHNIQUES TO HELP STUDENTS GENERATE & TEST HYPOTHESES ACROSS DISCIPLINES

Deana Senn
Robert J. Marzano
With Carla Moore and Penny L. Sell
The Essentials for Achieving Rigor series of instructional guides helps educators become highly skilled at implementing, monitoring, and adapting instruction. Put it to practical use immediately, adopting day-to-day examples as models for application in your own classroom.

**Books in the series:**

*Identifying Critical Content: Classroom Techniques to Help Students Know What Is Important*

*Examining Reasoning: Classroom Techniques to Help Students Produce and Defend Claims*

*Recording & Representing Knowledge: Classroom Techniques to Help Students Accurately Organize and Summarize Content*

*Examining Similarities & Differences: Classroom Techniques to Help Students Deepen Their Understanding*

*Processing New Information: Classroom Techniques to Help Students Engage With Content*

*Revising Knowledge: Classroom Techniques to Help Students Examine Their Deeper Understanding*

*Practicing Skills, Strategies & Processes: Classroom Techniques to Help Students Develop Proficiency*

*Engaging in Cognitively Complex Tasks: Classroom Techniques to Help Students Generate & Test Hypotheses Across Disciplines*


*Organizing for Learning: Classroom Techniques to Help Students Interact Within Small Groups*
Dedication

I dedicate this work to my parents, Lucie Verbois and George Senn, who raised me to take care and take risk (not necessarily in that order), and to my other parents, Kay Senn and Marvin Verbois, who also love and support me.

—Deana Senn
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Engaging in Cognitively Complex Tasks

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Introduction

This guide, *Engaging in Cognitively Complex Tasks: Classroom Techniques to Help Students Generate & Test Hypotheses Across Disciplines*, is intended as a resource for improving a specific aspect of instructional practice: helping students utilize their knowledge.

Your motivation to incorporate this strategy into your instructional toolbox may have come from a personal desire to improve your instructional practice through the implementation of a research-based set of strategies (such as those found in the Marzano instructional framework) or a desire to increase the rigor of the instructional strategies you implement in your classroom so that students meet the expectations of demanding standards such as the Common Core State Standards, Next Generation Science Standards, C3 Framework for Social Studies State Standards, or state standards based on or influenced by College and Career Readiness Anchor Standards.

This guide will help teachers of all grade levels and subjects improve their performance of a specific instructional strategy: engaging in cognitively complex tasks. Narrowing your focus on a specific skill, such as cognitively complex tasks, permits you to concentrate on the nuances of this instructional strategy to deliberately improve it. This allows you to intentionally plan, implement, monitor, adapt, and reflect on this single element of your instructional practice. A person seeking to become an expert displays very distinctive behaviors, as explained by Marzano and Toth (2013):

- breaks down the specific skills required to be an expert
- focuses on improving those particular critical skill chunks (as opposed to easy tasks) during practice or day-to-day activities
- receives immediate, specific, and actionable feedback, particularly from a more experienced coach
- continually practices each critical skill at more challenging levels with the intention of mastering it, giving far less time to skills already mastered
Engaging in Cognitively Complex Tasks

This series of guides will support each of the previously listed behaviors, with a focus on breaking down the specific skills required to be an expert and giving day-to-day practical suggestions to enhance these skills.

Building on the Marzano Instructional Model

This series is based on the Marzano instructional framework, which is grounded in research and provides educators with the tools they need to connect instructional practice to student achievement. The series uses key terms that are specific to the Marzano model of instruction. See Table 1, Glossary of Key Terms.

Table 1: Glossary of Key Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCSS</td>
<td>Common Core State Standards is the official name of the standards documents developed by the Common Core State Standards Initiative (CCSSI), the goal of which is to prepare students in the United States for college and career.</td>
</tr>
<tr>
<td>CCR</td>
<td>College and Career Readiness Anchor Standards are broad statements that incorporate individual standards for various grade levels and specific content areas.</td>
</tr>
<tr>
<td>Desired result</td>
<td>The intended result for the student(s) due to the implementation of a specific strategy.</td>
</tr>
<tr>
<td>Monitoring</td>
<td>The act of checking for evidence of the desired result of a specific strategy while the strategy is being implemented.</td>
</tr>
<tr>
<td>Instructional strategy</td>
<td>A category of techniques used for classroom instruction that has been proven to have a high probability of enhancing student achievement.</td>
</tr>
<tr>
<td>Instructional technique</td>
<td>The method used to teach and deepen understanding of knowledge and skills.</td>
</tr>
<tr>
<td>Content</td>
<td>The knowledge and skills necessary for students to demonstrate standards.</td>
</tr>
<tr>
<td>Scaffolding</td>
<td>A purposeful progression of support that targets cognitive complexity and student autonomy to reach rigor.</td>
</tr>
<tr>
<td>Extending</td>
<td>Activities that move students who have already demonstrated the desired result to a higher level of understanding.</td>
</tr>
</tbody>
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The educational pendulum swings widely from decade to decade. Educators move back and forth between prescriptive checklists and step-by-step
Introduction

lesson plans to approaches that encourage instructional autonomy with minimal regard for the science of teaching and need for accountability. Two practices are often missing in both of these approaches to defining effective instruction: 1) specific statements of desired results, and 2) solid research-based connections. The Marzano instructional framework provides a comprehensive system that details what is required from teachers to develop their craft using research-based instructional strategies. Launching from this solid instructional foundation, teachers will then be prepared to merge that science with their own unique, yet effective, instructional style, which is the art of teaching.

Engaging in Cognitively Complex Tasks: Classroom Techniques to Help Students Generate & Test Hypotheses Across Disciplines will help you grow into an innovative and highly skilled teacher who is able to implement, scaffold, and extend instruction to meet a range of student needs.

Essentials for Achieving Rigor

This series of guides details essential classroom strategies to support the complex shifts in teaching that are necessary for an environment where academic rigor is a requirement for all students. The instructional strategies presented in this series are essential to effectively teach the CCSS, the Next Generation Science Standards, or standards designated by your school district or state. They require a deeper understanding, more effective use of strategies, and greater frequency of implementation for your students to demonstrate the knowledge and skills required by rigorous standards. This series includes instructional techniques appropriate for all grade levels and content areas. The examples contained within are grade-level specific and should serve as models and launching points for application in your own classroom.

Your skillful implementation of these strategies is essential to your students’ mastery of the CCSS or other rigorous standards, no matter the grade level or subject you are teaching. Other instructional strategies covered in the Essentials for Achieving Rigor series, such as examining reasoning and identifying critical content, exemplify the cognitive complexity needed to meet rigorous standards. Taken as a package, these strategies may at first glance seem quite daunting. For this reason, the series focuses on just one strategy in each guide.
Engaging in Cognitively Complex Tasks

In the context of teaching students information, engaging in cognitively complex tasks is essential to learning in a rigorous classroom. As you become more skilled in implementing this strategy, you will see remarkable changes in your students’ abilities to use the information they have learned in your classroom. You will have a classroom of students who not only understand essential knowledge required by the standards but also can use that knowledge in novel situations. Whether a given standard is part of the CCSS or a set of district or state standards, your students will benefit from your expertise at engaging them in cognitively complex tasks. Picture the ultimate goal you have in mind for your students: the successful application of the knowledge and skills they have. This instructional strategy focuses on showing students how to use their acquired knowledge in more cognitively complex ways.
Engaging in Cognitively Complex Tasks

The cognitively complex tasks referred to in the title of this book demand higher-level thinking skills from your students, skills that ultimately lead to the generation and testing of hypotheses about knowledge they have acquired in your classroom. These types of challenging tasks require that students make decisions, solve problems, experiment, or investigate, and teachers do not readily observe these skills in classrooms (Marzano & Toth, 2014).

For students, the core of effectively engaging in cognitively complex tasks is the ability to produce and support claims. You and your students must master a structured and rigorous method for producing and supporting claims that includes these steps: 1) state a claim, 2) establish grounds, 3) provide backing, and 4) frame qualifiers to include describing counterarguments as well as identifying one or more of the four types of thinking errors (faulty logic, errors of attack, weak reference, or misinformation). Once students are familiar with the vocabulary and thinking processes necessary for producing and supporting claims in sources and content the teacher provides, they will be ready to tackle the more demanding task of generating and testing their own hypotheses about prior knowledge using techniques such as decision making and problem solving.

If you have not previously taught your students how to formally state and support claims, an earlier book in this series, Examining Reasoning, describes several techniques in which students learn how to support claims and assertions with evidence, produce and defend claims related to content, identify and analyze claims in an author’s work, and judge reasoning and evidence in an author’s work. These techniques lay the foundation by showing students how to engage in the thinking process of producing and supporting claims as a critical aspect of understanding and deepening their content knowledge. They prepare students for the rigor required for a new level of thinking: producing their own claims about content as well as generating and testing original hypotheses related to their content knowledge.

To fully understand this strategy, consider its context in a typical learning cycle or instructional sequence. Within every learning cycle, the effective
teacher uses various instructional strategies that intentionally move students toward more cognitively complex tasks and increasing levels of responsibility for their own thinking and learning. Your ultimate goal is that students will be able to engage in cognitively complex tasks related to critical content.

Note that students need to learn, practice, and deepen their understanding of content before you can expect them to utilize that knowledge to generate and test hypotheses. When implementing various instructional strategies, teachers should identify and plan for the interdependence and cumulative effect among instructional strategies. An example of interdependence can be explained in this short summary: Once a teacher identifies the critical content, the next step is to chunk that critical content and preview it with students. The teacher will then ask students to process that content. After students process the content, she further extends understanding by asking questions that require students to make inferences, or elaborate, about content. If the teacher desires to monitor whether students have internalized the critical content, she may ask them to record, represent, and even reflect on this knowledge. Then she might ask students to examine their reasoning about the content.

The italicized instructional strategies are not executed, nor do they have their intended effects, in isolation. Rather, a teacher with an instructional repertoire skillfully blends the strategies to achieve the overarching desired results.

Throughout learning, but most especially at the culmination of a specific learning sequence such as a unit or chapter, students should engage in activities that require them to experiment with their own knowledge and skills. In the course of producing and supporting claims and generating and testing hypotheses, students move beyond basic levels of knowing and gain the abilities and confidence to analyze their own understanding of content in novel situations.

**The Effective Implementation of Engaging in Cognitively Complex Tasks**

There are two aspects to the effective implementation of engaging students in cognitively complex tasks: 1) fully understand the process for producing and supporting claims, which lies at the core of this instructional strategy, and 2) thoughtfully consider the logistics of implementation.
Engaging in Cognitively Complex Tasks

Understand the Process for Producing and Supporting Claims

The effective implementation of engaging in cognitively complex tasks requires a basic understanding of the process for producing and supporting claims. If you are not familiar with the techniques presented in *Examining Reasoning*, Table 2 describes the steps and vocabulary associated with stating and supporting claims that you will find used and described in more detail in the techniques in this book.

Table 2: How Students Produce and Support Claims

<table>
<thead>
<tr>
<th>Step</th>
<th>Definition</th>
<th>Example</th>
<th>Teacher’s Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>State a claim</td>
<td>Students state claims based on their previous understanding (prior learning) of the content. They derive their claims in two ways: 1) based on the knowledge about content they have acquired and deepened to this point and 2) in response to a prompt or leading question about the content the teacher provides.</td>
<td>The Battle of Britain was the pivotal battle of World War II.</td>
<td>Students must produce their claims before they begin looking for evidence in support of their claims.</td>
</tr>
<tr>
<td>Establish grounds</td>
<td>Students collect evidence in support of their claims. This evidence is labeled <em>grounds</em>. <em>Grounds</em> contain the strongest and most persuasive evidence.</td>
<td>If Britain had been knocked out of the war, Germany could then have focused all of its resources on defeating the Soviet Union.</td>
<td>Evidence in support of students’ claims can be one of four types: 1) common knowledge, 2) expert opinion, 3) experimental evidence, and 4) factual information.</td>
</tr>
</tbody>
</table>

(continued on next page)
### Table 2: How Students Produce and Support Claims (continued)

<table>
<thead>
<tr>
<th>Step</th>
<th>Definition</th>
<th>Example</th>
<th>Teacher’s Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide backing</td>
<td>Students collect additional information about grounds that establish their validity. The backing is based on evidence unearthed through observation or investigation.</td>
<td>The British Isles could not have been used for staging during Operation Overlord.</td>
<td>The provision of backing will depend on the content, the complexity of the claim, and your students’ ability to sustain more extensive research into additional resources.</td>
</tr>
<tr>
<td>Frame the qualifiers</td>
<td>Students collect evidence that serves as qualifiers. Qualifying evidence is used to determine the strength of the students’ claims and consider the degree to which the countervailing evidence undermines or weakens their claims. The process of framing qualifiers can also include identifying common thinking errors that may weaken counterarguments.</td>
<td>There were other major countries battling Germany, and there were other fronts on which the war was being waged.</td>
<td>Qualifiers are an important aspect of stating and supporting claims. They serve to help students understand that the process of stating and supporting claims is more than finding supportive evidence. It also includes accounting for contradictory or confusing evidence that cannot be ignored. The common logical errors that are qualifiers to students’ claims include limits of statistical information, faulty logic, attack, weak reference, and misinformation.</td>
</tr>
</tbody>
</table>

Adapted from Marzano (2007), Marzano & Heflebower (2012), and Ocasio & Marzano (2015).

### Thoughtfully Consider the Logistics of Implementation

There are several logistics to consider if you are to effectively implement the techniques in this book: 1) the degree of choice you will grant to your students, 2) the degree of autonomy you will cede to your students, 3) the amount of time you will allocate for the collection of evidence, 4) the types of guidance you will provide to students, 5) the kind and amount of resources
Engaging in Cognitively Complex Tasks

you will provide, and 6) the overall duration of the cognitively complex task. While you may not fully understand or appreciate all of these considerations before you implement, use them to mentally walk yourself through the various lesson examples with your students and content in mind.

The Degree of Choice You Will Grant to Your Students

Grant students some choices during implementation, but provide boundaries to keep students focused. Provide a set of materials, resources, or specific guidelines to give parameters to their generation and testing of hypotheses. However, stop short of telling students the exact steps they need to take to prove or disprove their hypotheses.

The Degree of Autonomy You Will Cede to Your Students

When you implement a cognitively complex task for the first time, students will be uncertain about the process, especially if they are unaccustomed to making decisions about their own learning. In the beginning, devote more time to coaching and supporting them. Gradually, students will become more certain about your expectations, and you can then step back and let them work independently. Allow students time to ponder, debate, and even struggle a bit; however, do not ignore students’ frustration indefinitely. The secret to effective implementation of a cognitively complex task is doing all you can to ensure your students are doing the thinking work.

The Amount of Time You Will Allocate for the Collection of Evidence

An important consideration in the implementation of this strategy is giving students adequate time to collect needed evidence to support a conclusion. Whether you are facilitating a short-term cognitively complex task or a longer-term project, students need time to reach their own conclusions and support them with evidence.

The Guidance and Facilitation You Will Provide to Students

Plan in advance how you will support students throughout each cognitively complex task. The first step in providing guidance and support is to ensure that all students understand the complex steps involved in the task. Prepare to provide both verbal and written directions at the beginning of a
Engaging in Cognitively Complex Tasks

As students engage in cognitively complex tasks, be a highly visible and interactive presence. Move about the classroom to assist and monitor. Ask guiding questions to support student engagement and higher-level thinking. Give ongoing feedback to students as they engage in the task. Ask probing questions, intentionally thinking about how you can facilitate rather than tell, and guide rather than lead.

The Kind and Amount of Resources You Will Provide to Students

Volunteer a variety of resources. Assist students as they analyze their thinking and draw conclusions. Their success depends on your facilitating their learning through coaching and support. Identify the resources your students will need, and if necessary, secure those resources for students in advance of the activity. For example, fill a library cart with potential sources and make them available during the task. If students need internet access, point them to the most applicable and appropriate websites. If you wish, provide some lesser-quality materials so that students can compare and select the best. The ultimate goal is that students will decide for themselves which information is valuable and use it to support or test their hypotheses.

The Overall Length of the Cognitively Complex Task

Cognitively complex tasks are often viewed as long-term projects that require hours of research or experimentation and multiple class days to complete. Some cognitively complex tasks do fall into that category. However, the generation and testing of hypotheses can also take place during short-term lessons that lay a foundation for success with cognitively complex tasks that are sustained over longer periods of time. There are examples of cognitively complex tasks that vary in length within each chapter of this book.

Teacher Actions Associated With the Effective Implementation of Cognitively Complex Tasks

There are many teacher actions associated with the effective implementation of cognitively complex tasks. This list is not exhaustive, but it represents the diversity and intricacy of behaviors you might use to teach, model, and support effective cognitively complex tasks:
Engaging in Cognitively Complex Tasks

- Think aloud for students as you read the prompt.
- Teach and model for students how to generate a hypothesis.
- Provide opportunities for students to read and discuss the merits of other hypotheses.
- Identify essential steps in testing hypotheses.
- Provide guidance as students plan how to test their hypotheses.
- Teach students how to document evidence that confirms or disconfirms their claims.
- Provide opportunities for students to examine and analyze the strength of support presented for a claim.
- Model how to create conclusions that explain whether students’ hypotheses are confirmed or disconfirmed.
- Require students to support their conclusion with evidence.
- Circulate around the room to be readily available to students.
- Ask questions to help students think for themselves.

Common Mistakes

As you begin to implement this strategy, consider first how to avoid the following common mistakes. These errors can take your teaching, and ultimately students’ learning, off course:

- The teacher fails to provide a prompt that requires a cognitively complex response.
- The teacher fails to expect all students to state a claim.
- The teacher fails to release responsibility to students to think independently.
- The teacher fails to follow the process through to its conclusion and evaluation after asking students to generate a hypothesis.
Engaging in Cognitively Complex Tasks

Failing to Provide a Prompt That Requires a Cognitively Complex Response
Since cognitively complex tasks are usually the most rigorous activity you will ask a student to perform within a typical learning cycle, ensure that the task is at the level of cognitive complexity you intend it to be, usually the same level of cognitive complexity as the learning target.

Failing to Expect All Students to State a Claim
When time is of the essence, you may be tempted to rely on the answers of a few students to represent the thinking of the class. What is essential, however, about producing claims or generating hypotheses is not that the class as a whole states a claim or generates a hypothesis, but that individual students have an opportunity to examine their own thinking to generate a hypothesis. Ensure that structures are in place so that all of your students have opportunities and guidance to state their own claim as they begin a cognitively complex task.

Failing to Expect and Then Allow Students to Think for Themselves
If students are unaccustomed to examining their own thinking, they may not know how to even begin the process. So, with the best of intentions, you may decide to move the process along by telling students what to think rather than guiding them to examine their own thinking. The goal of hypothesis generation and testing is that students will learn how to examine what they personally know or think about a topic. If you tell your students what to think and how to conduct a cognitively complex task, you will be doing their thinking for them.

Failing to Follow Through After Asking Students to Generate a Hypothesis
You undoubtedly use predicting (generating a hypothesis) as part of your usual questioning techniques. During a read-aloud, you might ask students to predict what is going to happen next to the main character. While conducting an experiment, you might ask students to predict what will happen when you mix two chemicals together. Those predictions, while important, are only a beginning step. In the context of engaging in cognitively complex tasks, you must expect students to follow through and examine whether the evidence supports or does not support their predictions.
Monitoring for the Desired Result

As your students work at various cognitively complex tasks, your top instructional priority is to monitor their progress. The extra attention you provide while students are working individually or in small groups will pay rich dividends in student learning. As students are engaged in implementing one of the techniques, check to see if an individual or all of the individuals in a small group can explain their hypotheses. Determine if the evidence they have documented truly supports the prediction or claim they stated at the outset of the task. Stay in constant touch with students who are prone to struggling and help them get unstuck so that they can make the most of their allocated work time. Be available to guide or redirect students if they appear to be heading off course. Students learn more and retain knowledge more readily when teachers give them opportunities to revise their work based on what they learn along the way. Following are some examples that can help you determine if your students are able to engage in cognitively complex tasks:

1. When prompted, students can explain the hypotheses they are testing.
2. Students are able to test their hypotheses.
3. Students can identify evidence that supports or refutes their hypotheses.
4. Students can explain whether their evidence confirmed or disconfirmed their hypotheses.
5. Students can explain how their evidence confirmed or disconfirmed their hypotheses.
6. Students can explain common logical errors that may affect their hypotheses.

Each technique described in this book has examples of monitoring specific to that technique.
Engaging in Cognitively Complex Tasks

Scaffolding and Extending Instruction to Meet Students’ Needs

The purpose of monitoring is to collect evidence of your students’ progress in implementing a specific technique. As you monitor, you will notice that some students are not able to complete a cognitively complex task without extensive support and guidance, while other students are quickly able to complete the cognitively complex task and need more challenges to use their knowledge in novel ways. Examples of how to scaffold and extend instruction are included as part of the explanation for each of the techniques.

*Scaffolding* provides support that targets cognitive complexity and student autonomy to reach rigor. There are four categories of support you can provide for students who need scaffolding (Dickson, Collins, Simmons & Kame‘enui, 1998):

- enlisting help for students from their peers, instructional aides, or other paraprofessionals
- manipulating the difficulty level of content that you are teaching (for example, providing an easier reading level that contains the same content)
- breaking down the content into smaller chunks to make it more manageable
- giving students organizers to clarify and guide their thinking through a task one step at a time

*Extending* moves students who have already demonstrated the desired result to a higher level of understanding. These examples are provided as suggestions, and you adapt them to target the specific needs of your students. Use the scaffolding examples to spark ideas as you plan to meet the needs of your English language learners, students who receive special education or lack support, or simply the student who was absent the day before. The extension activities can help you plan for students in your gifted and talented program or those with a keen interest in the subject matter you are teaching who have already learned the fundamentals.
Teacher Self-Reflection

As with any skill you want to acquire or improve upon, reflecting is essential. The following set of questions begins with simply reflecting about how to begin the implementation process and moves to progressively more complex ways of helping students become autonomous learners as they generate and test hypotheses:

1. How can you ensure you and your students are incorporating the steps in each type of cognitively complex task your students are completing?

2. How can you provide resources and guidance to assist students with engaging in cognitively complex tasks?

3. How might you monitor the extent to which your students are able to analyze their own thinking as they generate and test hypotheses?

4. How might you adapt and create new strategies for cognitively complex tasks that address unique student needs and situations?

5. What are you learning about your students as you adapt and create new strategies?

Instructional Techniques to Engage Students in Cognitively Complex Tasks

There are many ways to engage students in cognitively complex tasks. The ways you choose to facilitate your students’ examination of their ideas, thinking processes, and logic will depend on your grade level, content, and the makeup of your class. These various ways or options are called instructional techniques. In the subsequent chapters, you will find six techniques to engage students in cognitively complex tasks. They are listed here:

- Instructional Technique 1: Investigating
- Instructional Technique 2: Problem Solving
- Instructional Technique 3: Decision Making
- Instructional Technique 4: Experimental Inquiry
Engaging in Cognitively Complex Tasks

- Instructional Technique 5: Inventing
- Instructional Technique 6: Student-Designed Tasks

All of the techniques are similarly organized and include the following components:

- a brief introduction to the technique
- ways to effectively implement the technique
- common mistakes to avoid as you implement the technique
- examples and nonexamples from elementary and secondary classrooms using selected learning targets or standards from various documents
- ways to monitor for the desired result
- ways to scaffold and extend instruction to meet the needs of students