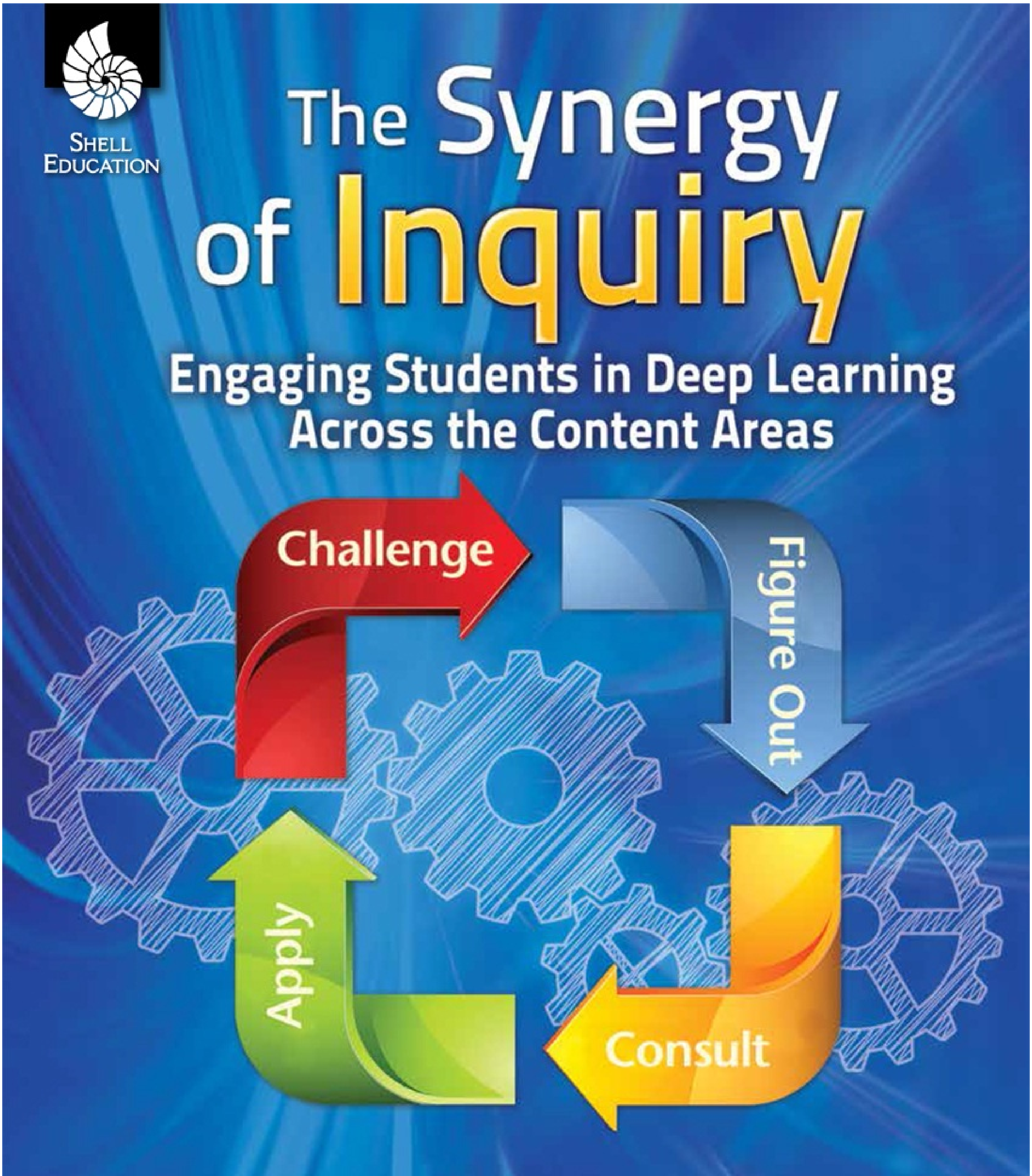

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The Synergy of Inquiry

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Chapter 1

Defining and Describing Inquiry Teaching

This chapter provides an overview of the components of inquiry teaching and describes classroom practices using these components. In this context, it is important to note that this approach does not ask you to abandon practices that work; the goal is to incorporate them into the inquiry teaching framework. Consequently, you can easily continue to use them.

You may find that you need to modify the size of the group with which you use a particular activity. Perhaps you will want to rearrange the sequence of activities in the learning process. For example, if you use Understanding by Design (Wiggins and McTighe 2005) as a planning format, you will discover that the model fits into inquiry teaching. Similarly, if you have your students working in cooperative groups, doing Socratic Seminars, or using a KWL (Ogle 1986) approach, you will see that these are compatible with inquiry teaching. Likewise, if writing partners, reader response, or arts infusion are elements of your practice, then inquiry teaching provides the perfect context for continuing these activities. Teachers who employ all the dimensions of inquiry teaching find that they have to alter very little, if any, of their day-to-day practices to address the relevant standards.

The Elements of Inquiry Teaching

Inquiry teaching is a method of facilitating learning where teachers provide situations in which students can successfully seek answers without being given answers. In the process of negotiating ideas amongst their peers with minimal assistance from teachers, students uncover concepts while simultaneously acquiring rational thinking skills.

Three over-arching goals or learning objectives provide a framework for the main features of an inquiry approach and should relate to:

1. Concepts—the relationship between ideas
2. Thinking skills—within and between disciplines
3. Habits of mind—thinking behaviors

All three goals are embedded in the small-group explorations and whole-class activities: they are not isolated in separate lessons. One learns to think academically by exploring something within and between disciplines. Students do the work of scientists, mathematicians, historians, sociologists, and writers or critics of literature. In doing so, they acquire conceptual understanding in each of the disciplines and across them, as well as developing problem-solving skills and habits of mind that foster effective learning.

Inquiry teaching has seven main features: student exploration, small-group learning, deep academic understandings and skills, problem solving, access to physical materials, relevance to student experience, and authentic assessment applications. Each feature is described as follows. Later in the chapter, you will find examples of how teachers at various grade levels have successfully employed these features.

Student Exploration

In an inquiry teaching approach, each lesson *begins* with students actively engaged in some authentic exploration in order for them to create their own naïve concepts surrounding any given question or topic area. Such lessons may take more than a day. Information about what the larger academic community knows on the same subject matter comes later. A brief introduction of five minutes or less *launches* the lesson and sets the context for the exploration, but there is virtually no new information given before students start their exploration. The creation and sequencing by teachers of these carefully crafted open-ended explorations is the most important aspect of inquiry teaching.

Small-Group Learning

These explorations almost always start with students working cooperatively in small groups of four or less. Learning can be a social activity. If the teacher effectively designs and facilitates the exploration, many students can learn more while working collaboratively than by working alone. Following the small-group activity, each group reports out its best thinking to the whole class. The teacher then facilitates the negotiation of these ideas among groups and students.

Deep Academic Understandings and Skills

Only during small-group explorations and whole-class discussions of ideas wherein students have deeply and thoroughly engaged in uncovering concepts and acquiring skills do they learn what the larger academic community has identified over the centuries. Students can now seek out from authorities the deeper, more complex answers to the questions they have formulated during their explorations and negotiations. They may extend their learning by reading, using media, or listening to the teacher. Students have already, during their explorations, created some relationships between factors, formulated some insights into the situation, and have a *landscape in their brain* that has missing elements. Now what they read, hear, or see has real meaning and relevance as well as a rich environment in their brain in which to be synthesized.

Problem Solving

Teachers and students are interested in hearing how students are approaching the solution to a problem rather than being told the answer. “What is your thinking so far?” is the key question the teacher asks a student or a student asks a peer. “What are the factors you are considering, and how do you think they relate to one another?” is another example of questions the teacher or students may pose. Such statements as, “Whenever possible, physically show your thinking to all of us in the class,” encourage further discussion.

Access to Physical Materials

Whenever possible, explorations should involve manipulating physical materials. Because of their developmental stage, almost all elementary and middle school students need to manipulate physical materials to enable them to create abstract concepts that are generalizable. Most high school students' brains and synaptic connections are ready for purely formal theoretical thinking. However, even they need opportunities to manipulate concrete materials in each subject area to create deep understanding of concepts. Studies demonstrate that most high school students have not had previous facilitated experiences with concrete materials and meaning making (Trifone 1991; Marek 1992; Kwon and Lawson 2000). In science and math, real materials can easily be found for students to use in designing and conducting investigations and finding approaches to solving problems. In social studies and English, primary source documents can be used for exploration. Having students engage in role-playing, doing simulations, interviewing, or engaging in reader response activities using quality literature provides appropriate experiences for exploration.

Relevance to Student Experience

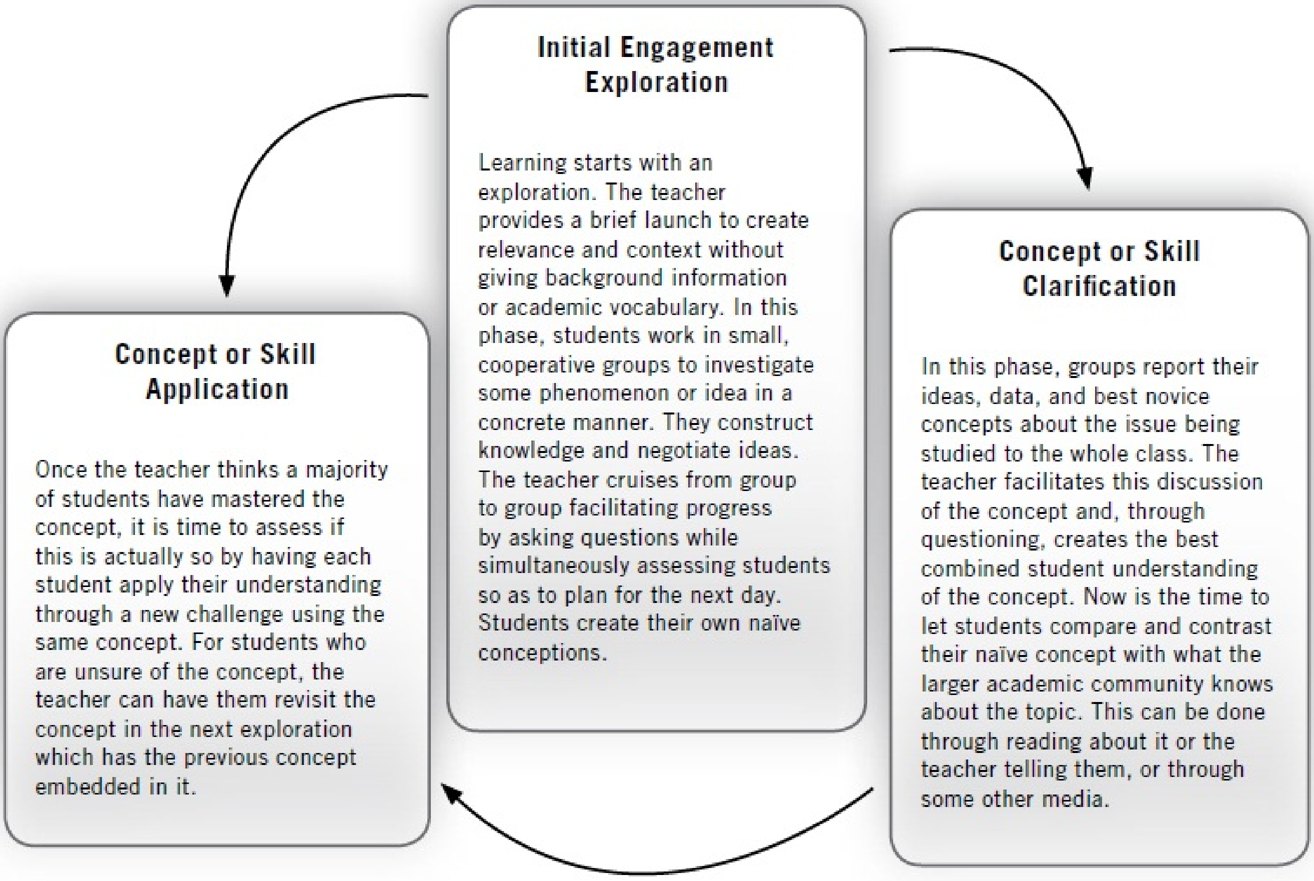
The materials, role-plays, simulations, or literature should contain or relate to themes or concepts that are important to the lives of students. The lessons need to be about the important issues related to students' lives at their stage in development. All of the lesson objectives need to be embedded within this context so that learning is meaningful and can be applied.

Authentic Assessment Applications

It is necessary for students to demonstrate their ability to apply any learning related to these concepts and thinking skill objectives to *unique*, *new situations* before we can say that they have deep understanding or mastery of skills.

Figure 1.1 describes how these seven features come together in a three-phase cycle: exploration, clarification, and application. The cycle begins with initial engagement through exploration, followed by concept or skill clarification, and moves to concept or skill application.

Figure 1.1 The Inquiry Teaching and Learning Cycle



In the sections that follow, each element of inquiry teaching is elaborated on and classroom examples are provided in various subject areas and grade levels. The remaining chapters provide details about how to operationalize these ideas in your classroom and why each one is such an important component in helping students become masterful learners. Additional examples can be found on the Digital Resource CD.

Student Exploration

Inquiry teaching and learning begins with a student exploration. This may sound counterintuitive to those using transmission approaches to teaching, but this is the key component of inquiry teaching. The teacher designs an exploration where students, working in small teams, actually get to experience the concept that is the object of the lesson. As you will see in the examples that follow, students are given a challenge where they can intuit the concept from having experienced it, or they can design a solution or approach to a problem that builds on the last set of skills or understandings that they have just mastered. It is important that the exploration be carefully designed such that the desired concept or skill is the main focus and can surely be figured out by the group working together as they interact and create their best understandings.

Student Exploration in Practice: *Eighth-Grade Poetry Lesson*

"I picked this poem because I love the way the poet seems to paint with words. Where it says 'patent leather streets,' you can just see the streetlights glistening off of the rain-soaked streets without saying all of that. What a great comparison!"

The teacher, Sara, added two items the student noted—"Paints with words" and "Good comparisons"—to the list on chart paper. Sara then asked who wanted to go next. Many students were now eager to share their ideas knowing that these would be respectfully accepted and questioned only for clarification by the teacher or other students.

A student read another brief poem. It seemed that with each subsequent reading, students were taking more and more care to read them for meaning, or with emotion, or in this case, playing with the rhythm a bit.

"I picked this one for two reasons. It was one of the few poems that rhymes, and it almost has a rhythm to it like a song. It is far from rap, but it is the closest thing here to it."

Sara added these two additional elements—"Rhyme" and "Rhythm"—to the chart labeled "Elements that Make Poetry Interesting."

At the beginning of the period, Sara had placed 16 different poems in piles with five copies of each around the perimeter of the room. She then asked the 32 eighth graders in the class to walk around quietly and read each one and then pick the one that they liked the best. After making their choices, students returned to their seats and wrote down which aspects of the poem made them select it, whenever possible referencing particular words or lines. Once they all had selected a poem, they first explained their choices to their small feedback groups of four where they practiced their reasoning. Next, they reported to the whole class. Other students spoke about "words in a row beginning with the same letters," "emotions I felt from reading it, like love," or "how the words were positioned all over the page—but for a reason. It made you think, and say them differently." Everybody had their reasons and when ones were repeated, the teacher placed additional check marks on the chart next to those.

As the period was about to end, Sara asked students to copy down all of the reasons. For homework, they were to see if they could fit them into categories. The next day, students came back with suggestions of categories like "sounds of words," "cool comparisons," "musicality and rhythms," and "intense emotions."

Soon students had uncovered almost all of the elements of poetry. They had negotiated these ideas first in their small groups and then created knowledge as a whole class. Not all of the students owned every idea yet. However, since they participated in creating the concepts, many of them at least partially owned them. Later in the week, the teacher introduced the academic vocabulary, such as alliteration, that went with each of these concepts. If the teacher had started with the vocabulary, then students would think the vocabulary, not a deep understanding of the concept, was most important. This would have created the wrong focus.

Sara understood that this was just their initial exploration together into the world of poetry, and this would need to be followed by a spiral of further explorations for deeper understanding of each aspect. So began a discussion about why they had not all picked the same poem. This led to a discussion of why some students thought poetry was "dumb," and why did the person not just write out what they wanted to say in a paragraph. Sara referred to one poem and said the poet said that when he could not express his emotions by speaking, he would write them down in a poem and give it to the person. Some of the students spoke about how they thought some of these poems weren't so great. That led some other students to ask them if they could write better poems. "I'm only a teenager. What do you expect of me?" was a common answer.

Sara said they would be reading much better poems than these in the coming weeks and that the class would also be publishing an online book of their own poetry with drawings and photographs. Just as the class was about to end, Sara said, "By the way, all these were poems that I wrote when I was a teenager. I'm sure you will all do much better."

Observations About Student Exploration in Practice

Many times teachers equate student explorations or investigations with doing science. What you see on the previous page is a teacher who has carefully created and facilitated an *exploration* lesson in language arts. After clearly delineating the concept, skill, and habit of mind objectives, the teacher took much thought to design and facilitate an exploration that would allow students to uncover the concepts while practicing their thinking skills. By uncovering conceptual relationships, students then truly and deeply understand these relationships and can use their thinking skills to apply them, simultaneously acquiring a deeper skill level.

Everything we have learned about learning over the past four decades demonstrates that these conceptual understandings and skills cannot be transmitted through telling—didactic teaching. Whether you look at the studies by Piagetian developmental psychologists (Bruner 1960, 1973, and 1996; Elkin 1976; Flick 1995; Fischer 2008) or the current brain-based researchers (Bransford et al. 1999; Zull 2002), each of the multitudes of studies demonstrates that students need to create understanding and acquire skills by engaging in designing and carrying out explorations within and between disciplines. This must be done before students can be exposed to what the larger academic community already knows so that they can then compare their understandings with those in academia. During this phase of inquiry teaching and learning, students are creating relationships between many of the factors involved in a given phenomenon, conceptual relationship, or problem-solving approach to a specific situation. Many times, students' understandings and skill sets are naïve, but they have painted a *landscape* with gaps. This landscape is an area in their brain that is wrestling with understanding the phenomenon. These gaps are the questions they now have that can be answered by what members of the larger academic community have themselves uncovered.

In the above example, students in a class will not necessarily uncover every element of successful poetry. They will need to be exposed to these additional elements. They still need to look at how great poets have utilized various devices, alone and in tandem, and be able to recognize why these poets were or were not successful. They need to create poetry themselves and practice using a number of these poetic devices. They need to practice giving friendly critiques with positive suggestions for improvement of their classmates' poems. All of these are follow-up explorations in a sequence or *spiral* of lessons.

The Teacher's Job in Inquiry Teaching

"Every time you answer a student's question you stop them from learning."

"The hardest part for a teacher in inquiry teaching and learning is to stop talking."

I introduce many of my workshops with the first of these two statements and repeat the second many times throughout the workshop as teachers work on their plans for student explorations. Once teachers try their plans in their own classrooms, they are the ones using the second quote.

Both of these are counterintuitive given almost everything we have experienced ourselves in formal schooling. Is it not the teacher's job to answer questions, distribute knowledge, and therefore, speak?

Students need to uncover concepts for themselves by engaging in well-crafted explorations that enable them to deeply understand concepts and apply them to multiple situations. Teachers need to stop answering questions as this actually inhibits students from creating deep conceptual understanding.

Likewise, when students are engaged in well-designed explorations, they need to be allowed to *struggle* to figure out their own understandings. Since they are in small groups, they can support one another. The teacher needs to be "cruising" the room from group to group, carefully listening to see if and when intervention may be required. However, teachers need to restrain themselves from engaging prematurely. Figuring out takes time, and wrong roads need to be taken and abandoned. Allow students to think on their own; let them struggle. If the exploration is designed appropriately, it will only be occasionally that a teacher will need to "drop a not too leading, but well thought out question" into a group that has moved too far astray for too long. If you just wait, most of the time, students will go down the road you were about to lead them on to. Except, now they do the figuring out and they own the knowledge in a much deeper way.

Thinking Space

Teacher Talk

Think about the amount of time you spend talking to your students during the course of a single class or throughout the day.

- What are the purposes of your talk?
- To what extent do you find yourself repeating student questions or answers?
- To what extent do you use talk to encourage students to think on their own or to share ideas with their peers?
- How difficult do you think it will be for you to change the pattern of teacher

and student talk in your classes?

Small-Group Learning

For millennia, humans have learned how to solve problems and better themselves by working in family units, tribes, and more recently in engineering teams, poetry collaboratives, and other small groups where thinking and ideas are shared, tested, and applied. Students not only have an opportunity to have a lot of time to verbally work through their thinking but are also more likely to verbally try out their newly-created ideas in a small group rather than in front of the whole class. This group negotiation of ideas allows students to compare their thinking with others in the group, and it also allows the teacher to go from group to group to carefully listen in and see where students are currently as they move towards mastery of the concepts and skills.

Small-Group Learning in Practice: *Fourth-Grade Science Lesson on Heat*

Part One

In a fourth-grade class, the teacher, Debbie, had begun the study of heat a couple of weeks earlier by asking students what they knew about heat. Most of their observations about heat were correct interpretations about how the natural world works. For example, they observed that the flame on the stove makes both the pot and the water in it hotter. However, one student said that "clothes have heat" and many of the students agreed with this idea. They demonstrated "evidence" by pointing out that if you put on clothes when you are cold in the winter, that you get warmer. One student also pointed out that her mom said, "Put on your warm clothes."

Based on students' observations, Debbie modified the plans she previously created for her students. These plans included explorations for letting students *uncover* how heat is transferred from one place to another, how certain materials—insulators—keep heat from moving easily, and how a thermometer measures the average amount of heat in a given spot. She now included some explorations where students could figure out if "winter clothes" contained heat or simply kept "the heat from humans" from moving outside the body.

Each day, students looked forward to the teaching, saying it was time for science research teams. Students, seated in their groups of four, would clear their desks and the "getter" from each group would assemble the materials to either continue their exploration from their previous science team time or to wait for a new challenge to build upon their ever-increasing knowledge and skills.

Part Two

Debbie gave students hot and cold objects and thermometers to use in their small science research teams. They designed experiments that answered the question of what would happen when these objects are put various distances from one another. Some groups just put the items touching one another. Other groups put them at various distances from one another, keeping track of how far apart they were, asking the teacher for a ruler. Others did not use a ruler and just said *touching*, *near,* and *far.*

Some kept track of the time and others just said "after a while." Students argued their point of view for how the experiment should be designed until the group came to a compromise. Everyone kept notes in their "science journals" in bound notebooks since initial notes about the thinking and data are never altered. It was important for them, together with the teacher, to see the evolution of their thinking so these notes were "sacred." Groups then carried out their experiments.

A week or two into the study of heat, the teacher had students in each small science research team bring out some winter clothes. Students used the same experimental designs that they had formulated in other explorations to determine for themselves whether the clothes "had heat" or just "insulated heat produced by the human body." Most groups quickly designed experiments that gathered evidence that the clothes were no warmer than the room that they were in, but they did function as good heat insulators. All of them had been working on "controlling variables" as they designed their experiments, with Debbie nudging them in that direction with well planned questions. As always, groups reported their results, and the "scientific knowledge of the class"—what they knew—was altered by the whole class community of scientists. It would take a while for *all* students in the class to be completely clear in this understanding. However, having students working closely and intensely with one another allowed both the teacher and the other students in their group to move students' understandings along much more deeply and quickly. All of the students soon owned the concepts and skills.

Observations About Small Group Learning in Practice

Within these small groups, each student had space and time to explain their ideas about what they were investigating, how they should design the investigation, and how they could best interpret the results. These groups were heterogeneously grouped so that there were students with varying levels of academic readiness in each group. Many decades of research demonstrate that if teachers work correctly with these groups, each of the individuals will achieve as highly as if they were in homogeneous groups, including the most advanced students. However, the at-level students will work slightly better, and students previously lagging will more quickly approach on-level achievement than if they were homogeneously grouped (Slavin 1996; Rohrbeck et al. 2003; Johnson and Johnson 2009).

Learning can be a social activity. Lev Vygotsky's work (1978), and more recently, neuroscience brain-based research (Zull 2002) all confirm that deep understanding and acquisition of applicable thinking skills are most successfully acquired through verbal interaction of students while they are engaged in physically manipulating materials in order to solve a problem. After the teacher launches the exploration, students work as a team in small groups to create understandings. They verbally negotiate ideas, facilitated by the teacher's questions only when necessary. Teachers create many of these questions during their lesson planning, so they are "right in their hip pocket" when they are needed as they cruise the room listening to the student conversations.

Since learning takes place in this verbal interaction, students live most of their lives in classrooms in these small groups. The groups are changed up every four to six weeks. As we will see later in this book, students need to be taught the skills to work cooperatively, effectively, and positively to support one another in these groups. The activities that teach these skills must become part of the classroom curriculum.

The teacher roams the room as the groups are engaged and makes observations about student performance. From the group dialogue, the teacher can assess various students' initial understandings and can differentiate instructional interventions with individuals or duos based upon how students are explaining their thinking. Since the other students in the class are truly engaged in the exploration, there is time to focus on individuals in the small groups. Likewise, if there are particular individuals who already own the concept or skill early into the lesson, the teacher has already planned an enriched version of the skill or concept using the same investigation for these individuals.

The Teaching and Learning Cycle

The Inquiry Teaching and Learning Cycle (see Figure 1.1) is a modification of *The Learning Cycle,* a teaching procedure Robert Karplus and Herb Thier (1967) invented as they were working on elementary curricula at University of California Berkeley. However, over the years it has been demonstrated that this approach is how students of all ages best learn. Karplus and Thier saw that learning is about the academic discipline—how the knowledge is created in that discipline—and doing and learning that discipline knowledge needs to be embedded in an approach in which students naturally learn. Their response was chosen to nurture the learner's natural curiosity and joy of learning. They saw that memorizing and repeating does not represent a discipline and that a subject is the quest for knowledge, not just the knowledge itself. They field tested their approach with thousands of students and found that if learners explored a phenomenon and noticed how as adults we thoughtfully responded to their thinking, students then constructed ideas, skills, and attitudes about the subject area that lasted a lifetime. Students who used the learning cycle were superior in both cognitive and motivational behavior (Kyle and Bonstetter 1992).

The learning cycle is based on Piagetian theory (1963; 1969) and also operationalizes David Ausubel's theory of meaningful learning (1963). We now understand that the learning cycle also fits into Vygotsky's social constuctivist theory (1978). Likewise, current brain neurobiology research and learning theory supports the learning cycle (Zull 2002).

It is 55 years since the invention of the learning cycle, and although I have made some important modifications, the basis of the learning cycle is still at the heart of inquiry teaching and learning. A colleague of Karplus and Thier, John Renner (1971, 163) explains that "True learning comes from the search for the answer and not the answer—this is the essence of inquiry."

Deep Academic Understandings and Skills

Only after students have created a rich set of concepts and spent reasonable time building skills are they then exposed to what the larger academic community knows. Once students have negotiated their ideas by engaging in small group explorations, they have established a place in their brains that interconnects many of the factors involved in the concept. With the teacher's leadership, they can first compare and contrast their ideas with other groups and come to some class consensus. Only then do they have real questions about the concept that they want answered and have enough of the landscape created so that they can make sense of what the larger academic community understands. Students can distill meaning from reading, media, or even lecture. These sources of understanding become meaningful enterprises.

Deep Academic Understandings and Skills in Practice: *Eleventh-Grade Chemistry Lesson*

Erin, the eleventh-grade chemistry teacher, has each student individually manipulating large needleless syringes. Students have been directed to manipulate the syringes and keep track of what happens. She asks each student in their four-person research team to clearly state to the others *what* they did and *how* the syringe reacted. If the others did not do this, or see a different reaction, then each student has to do it until they come to consensus in the group.

When all students in the group have responded, they return to the first student who spoke and try to reach consensus on *why* the particular actions produced the result they observed. In the midst of the group discussions Erin, after cruising the room, stops the groups and says that in a few minutes the reporter in each group needs to report on the data and insights that they have gathered thus far. As the reporters begin to report their results, the teacher writes down each observation word for word. When the reporter mentions something about "the plunger in the tube," Erin interrupts and asks, "What is the plunger?" A discussion ensues that leads to the need for a drawing and labeling of parts of the syringe. Erin gets class-wide agreement upon generic names for each part so that they each use the same vocabulary in their scientific community. One of the large concepts she is building is an aspect of the *nature of science*. The ability of the community to monitor itself by running replicable controlled experiments and to use a universal language is one aspect of this nature of science.

During this time, Erin is also slowly letting the class create operational definitions for words they are using in their reporting of their explorations so that they can see that in science there are no facts, just the best understandings that can be supported by evidence from carefully constructed experiences. Each time the class uncovers some new insights, there is greater conceptual understanding and the definitions expand, or are modified. In this way, another aspect of the nature of science is modeled.

However, she also focuses the class on the content—concept objective—during the two or three days of the lesson. Erin can soon question the reporters about how they know there is "stuff" inside the syringe. After all, students keep saying there is "air" in the tube, so Erin asks anyone for evidence that there is "stuff" in the tube. Soon someone notes that when you cover the "tip" tightly with your finger and push down on the plunger that was originally partially up the tube, there is something in the tube that pushes back. Within five minutes a combination of students have come up with this statement: "When you cover the tip tightly with your finger and push in the plunger, then the space in the tube (the volume) gets smaller and the gas in the tube gets compressed and the pressure increases and 'pushes back'."

Erin recorded the students' statement; as discussion continued, the statement was modified to make it clearer, more accurate, and acceptable to all in the class. She also used different colored markers to show the changes.

This method allowed the class to literally see knowledge being negotiated and created.

The teacher labeled the statement the "Marion and Dennis Law" after the two students who came up with most of the insights based on evidence. For homework, the teacher gave students a challenge to apply this concept to inflating their bicycle tires. The next day they discussed how they tried to apply their understandings to this new situation. The teacher decided that most of them owned enough of the concept that they were ready to compare their understanding of this phenomenon to what the larger scientific community knows. The teacher assigned them some pages in their chemistry textbook to read where they would find that the Marion and Dennis Law was first put forth in the 19th century and is called Boyle's Law. The next night students looked on the Internet at an animated simulation of the molecular interactions of these factors.

Later in the week, students tried to calculate the numerical relationship between the pressure and volume using measurement tools. With some prompting by the teacher, they uncovered the need for a constant in the equation they were formulating but there is no way that students could uncover the need for taking into account the amount of moles of molecules. Since they had created the landscape in their brains and had questions that they could not answer themselves through exploration, students realized that they needed help from outside resources. The teacher explained what professional scientists understand and how they came to understand it.

Observations about Deep Academic Understandings and Skills in Practice

I hope that it is becoming apparent that inquiry teaching and having students do inquiry in a discipline are related, but different. Inquiry is the process by which humans learn things, that is, create knowledge. What defines knowledge as acceptable in one discipline is somewhat different from what makes knowledge accepted in other disciplines. In science, for example, knowledge about a particular phenomenon is accepted by the scientific community if evidence in carefully controlled experiments can be replicated with the same results. As soon as there is one place or time that the idea does not work somewhere in nature, then the idea is modified. In history, there also needs to be evidence that something occurred in the human community, but that evidence is a human being's interpretation of what they saw and heard. Why an event occurred is even a further interpretation of the event and the events surrounding it. There can be different interpretations by different people of the same evidence about an event. In science, the evidence and models need to match the natural world and can be universally tested. The social science of history is much more dependent on the predisposition of those writing about the event. That is what we mean by the *epistemology of a discipline.*

Inquiry teaching is a method of facilitating learning where a teacher designs an exploration in which students engage in some modified form of inquiry within or between disciplines in order to uncover some understanding. In the course of the inquiry, students' rational thinking skills are enriched. The teacher identifies a specific understanding or skill for students to own. The teacher engineers the exploration to lead students to uncover that understanding. Students are actively figuring stuff out, but it is not an open inquiry that is completely under the control of the student. There is a place for open inquiry in schools; however, it is a small percentage of what constitutes inquiry teaching (see Heidi O'Donnell's reflection in Chapter 3). In inquiry teaching, students also actively compare their understandings to what the larger academic community knows and then apply their enriched understanding to unique applications to see if it is a deep, usable understanding.

Vocabulary Comes at the End of the Week

Notice that in the chemistry class, Erin began with students using common, generic names for things. Only after students *uncover the concepts* and have some ownership of them, does she *drop* some academic names during discussions. Erin uses "cylinder" instead of "tube" and "piston" in place of "plunger." Students ask why they cannot continue to use the original terms. She reminds them how it was necessary for the class to come up with a common vocabulary so that they could communicate between research teams within the class and to accurately compare experimental results. Students begin to see that if they want to know what the rest of the academic community outside their classroom knows about this topic, then they need to use the same vocabulary the rest of the scientific community has agreed upon.

Sometimes students will use the scientific vocabulary because the term is also a "common generic" word with a similar meaning. In this case, they have been using "pressure" as they created a deep conceptual understanding. Now they can read texts, written or audio and video media, with which to compare their understandings. Since they own many concepts and have now connected them with academic vocabulary, they can read for meaning. Many decades of experience and research (Beck et al. 1987; Bravo and Cervetti 2008; Jablon 2011) have demonstrated that if teachers use academic vocabulary before students create conceptual understandings, students focus on the vocabulary and not the conceptual relationships or the skills in using them. Simply stated, vocabulary instruction *comes at the end of the week* after students have some ownership of the concepts and skills.

Problem Solving

"What is your thinking so far?" not "What is the answer?" are concepts central to the inquiry teaching and learning process. As noted earlier, concepts cannot be taught; they need to be learned, that is, constructed by the student. Creating deep understanding requires that students actively engage in figuring out—problem solving. Asking students to focus on what they understand so far, rather than asking them for the right answer, introduces them to metacognitive learning. They begin to take ownership and responsibility for being competent, successful learners. They realize that persistence on their part is rewarded, even if they have not totally mastered a concept. Their peers and teacher are always there to support and assist them through their journey with their thinking.

Problem Solving in Practice: *Second-Grade Thinking in Action*

Migdalia spent most of first grade hiding quietly behind the student sitting in the row in front of her. Her first-grade teacher constantly asked students in the class for the right answer to questions that she posed in each of the subjects. Migdalia was rarely sure of her answers, so she hardly ever raised her hand. The few times she did, she usually did not have the right answer, so she raised her hand less and less so as to not embarrass herself in front of the whole class.

However, this year in second grade, Migdalia's teacher, Diane, has always asked students for their thinking so far. Since students work on their explorations in small groups of four, Migdalia gets to try out her thinking as she manipulates materials in front of only a few people. The others in her group try out their ideas too, and they then try to come to the best thinking they can. Whoever is the designated reporter for the day then reports out to the rest of the class the group's thinking. Now when Diane asks for volunteers during whole class discussion, Migdalia regularly raises her hand because the teacher is not interested in hearing her right answer, just her best thinking. Little by little, as the term goes on, the other students also start listening closely to each other's best thinking and begin to seriously negotiate ideas. The teacher does have the eventual goal of the "right" answer, the concept or skill we want each of the students to own, but realizes that this is the most effective way to reach that objective.

Observations About Problem Solving in Practice

The whole classroom takes on a supportive atmosphere where everyone becomes interested in "figuring out how to figure stuff out." This leads to students feeling safe in acquiring high-level thinking skills and deep conceptual understanding.

Problem solving is an important aspect of the CCSS in language arts and mathematics. Figure 1.2 shows the relationship between the stages of the inquiry teaching and learning cycle and selected Common Core ELA/literacy standards. Figure 1.2 references anchor standards for the 6–8 grade band in four areas: Reading Informational Text, Writing, Speaking and Listening, and Language Anchor Standards, which define general, cross-disciplinary expectations for each strand. The anchor standards are labeled according to the strand and number of the standard; for example, CCRA.R.2 signifies college and career readiness anchor standard (CCRA), reading strand (R), anchor standard two (2).

Figure 1.2 Examples of Alignment between Inquiry Teaching and Learning Cycle Phases and Selected Common Core ELA Standards for Grades 6–8

Inquiry Teaching and Learning Cycle Stage	Reading Informational Text	Writing	Speaking and Listening	Language
Identification of the task (*Exploration*)	CCRA.R.2 CCRA.R.4		CCRA.SL.1	CCRA.L.3 CCRA.L.4 CCRA.L.6
Design a strategy or method to explore (*Exploration*)		CCRA.W.7 CCRA.W.8 CCRA.W.9	CCRA.SL.1	CCRA.L.1 CCRA.L.3
Analyze ideas Research and develop a tentative argument (*Exploration*)	CCRA.R.4	CCRA.W.1 CCRA.W.2 CCRA.W.4 CCRA.W.8 CCRA.W.10	CCRA.SL.1 CCRA.SL.2 CCRA.SL.5	CCRA.L. 1, 3, & 6 CCRA.L2
Critical friends as groups report out (*Concept Clarification*)	CCRA.R.8 CCRA.R.9	CCRA.W.4 CCRA.W.5	CCRA.SL.1 & 2 CCRA.SL.3 CCRA.SL.4 CCRA.SL.5 CCRA.SL.6	CCRA.L. 1, 2, 3, & 6
Explicit and reflective discussion (*Concept Clarification*)	CCRA.R.7 CCRA.R.9		CCRA.SL 1, 2, 3, 4, & 6	CCRA.L. 1, 3, & 6
Write a report that compares naïve ideas with academic community ideas (*Concept Clarification*)	CCRA.R.1 CCRA.R. 2, 4, & 8	CCRA.W. 1, 2, 4, & 10 CCRA.W.6		CCRA.L. 1, 2, 3, & 6 CCRA.L5
Student and teacher feedback (*Concept Clarification*)	CCRA.R. 1, 2, 4, 8, & 9 CCRA.R.3 CCRA.R.5 CCRA.R6	CCRA.W. 2 & 5	CCRA.SL. 1, 2, 3, & 4	CCRA.L. 1, 2, 3, 5, & 6
Revise and submit report (*Concept Clarification*)	CCRA.R. 1, 2, 3, 4, 5, & 6	CCRA.W. 1, 2, 4, 5, 6, & 10		CCRA.L. 1, 2, 3, 4, 5, & 6
Unique application with written response (*Application*)	CCRA.R. 1, 2, 4, & 8	CCRA.W. 1, 2, 5, & 10		CCRA.L. 1, 2, 3, & 6

Adapted from Enderle, Grooms, Campbell, and Bickel 2013; CCSSO 2010

Access to Physical Materials

Having students manipulating materials is a *must do* in effective inquiry teaching. Think back to your child or adolescent development class during your teacher-preparation program. Understanding students' brain development is crucial in being successful with their learning. You might remember that Jean Piaget was one of the pioneers and most important individuals in understanding this development. However, it was a while into my own teaching career before I truly understood the importance of having students manipulate materials. Piaget and Inhelder (1969) did not say it is a good idea for students at the preoperational or concrete-operational stages to manipulate materials so that they can learn. They said students *have to* manipulate materials in order for them to learn anything of consequence. Sure, they can memorize facts for a few hours to pass a quiz. However, in this era of Common Core and 21st century skills, the findings of Piaget (1963), Bruner (1973, 1996), and all the developmental psychologists since (Elkin 1976; Flick 1995) can no longer be ignored. The notion that students have to manipulate materials was one of the most sobering realizations that I ever had to face as a classroom teacher. Once students had materials in their hands that they were using in a meaningful way a majority of the week, not only did they learn more deeply, but also their behavior and attitude about putting effort into learning changed for the better.

Thinking Space

Teacher Talk

Common Core State Standards (CCSS) and My Planning

Reflect on your recent experiences with implementation of your state language arts standards and the move to implementation of the Common Core State Standards.

- To what extent are you familiar with or implementing the CCSS? What is (or has been) your reaction and that of your colleagues to the Common Core?
- In what ways do you think the Common Core will impact your planning and instructional practice?
- What type of support is being provided to enable your successful transition to new standards?
- Do you already use inquiry-teaching strategies? If so, which of your current : strategies are consistent with the expectations of the Common Core?

Access to Physical Materials in Practice: *Eighth-Grade History Lesson*

It is one thing to memorize when, where, and what occurred during John Brown's raid just before the Civil War. It is another thing to realize that historical accounts of what and why it happened are all about point of view of the author of the text. Whether you are studying this in the sixth or tenth grade will also determine the level of complexity of the historical ethics that students are expected to comprehend. The teacher, Mike, involved in this lesson is not only having students "doing history," but he is also responding to the Common Core expectations for reading complex nonfiction texts.

However, Mike has been practicing effective inquiry teaching long before publication of the Common Core State Standards and has been addressing the same expectations as part of the inquiry plans. So instead of telling the story of John Brown's Raid when the class reached that era in history, Mike created as much of a hands-on exploration as is possible in history. As a result, the previously disengaged students became completely engaged.

Prior to this lesson, with the permission of his principal and the parent's advisory committee, Mike had students out in the school yard pulling 100 pound "bags of cotton" for 50 yards on a 90 degree day while doing squat thrusts every 20 feet to simulate what it was like to be a slave and pick cotton. Students did this for 15 minutes and then discussed what it would be like to do this for 10 to 12 hours a day, six days a week, starting when they were eight or nine years old and doing it for the rest of their lives.

Next, students worked in their small groups. Each of the groups had a copy of one of five original accounts of the raid from October of 1859. Using the ideas they unpacked from the text of the primary source document they were assigned, students were challenged to create a one-minute newscast that they videotaped using a mobile device. At the beginning of the next class, these newscasts were played back to the whole class through an LCD projector. Students began to respectfully critique each other's accounts, saying that the others had misinformation or were looking at the situation in a really biased way.

Mike had gone to the Library of Congress and the U.S. National Archives website and found five documents, each with a different perspective. One was from a northern abolitionist-leaning newspaper. Another was from a local West Virginia newspaper. Yet another was from an inflammatory writer in a South Carolina paper. The other two were more middle-of-the-road writers, but each took at least one point of view on one of the many complex ethical issues involved. After this back and forth in class, students went home and were asked to imagine they were a teenager living in 1859. Each of them was assigned a different situation.

Some of them were white, some African-American; some from the South, some from New England; some rich and some poor; some free and some slaves. They were to write down how they would feel about this "civil disobedience." The next day, Mike paired each of them, and one by one they had three minutes to role-play a discussion they might have if they had met and chatted. The teacher had various hats, scarves, and tools as props that each student could use. Out of the discussion of "right and wrong," "fair and unfair," and "legal or not legal," grew most of the issues that Americans were facing before the Civil War, how those led to the war, and how it even might have been possible to avoid it. The majority concrete-operational students were able to do complex formal thinking because of their "concrete" manipulation of primary source documents and through role-playing of "real teenagers."