

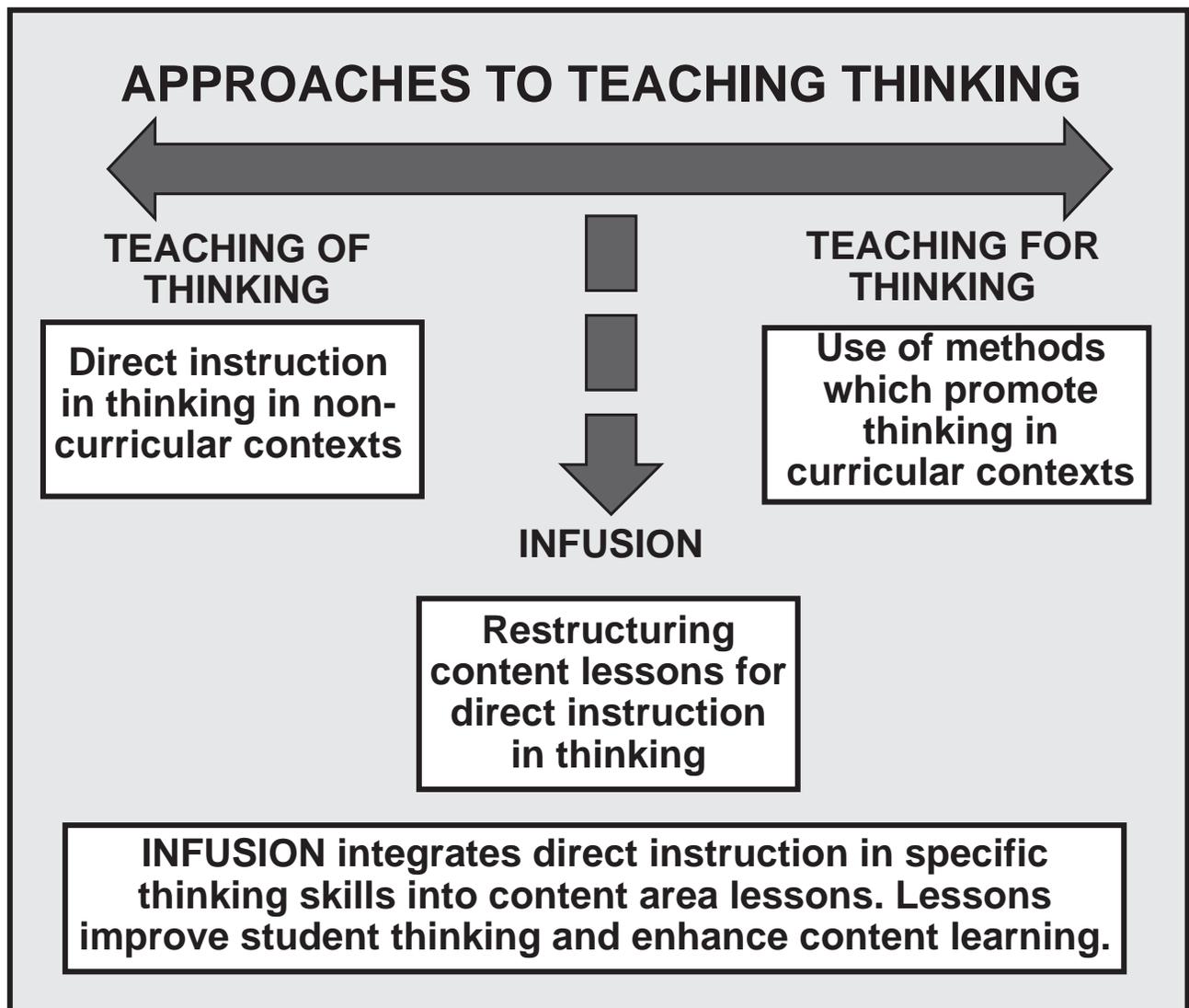
# PART 1

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## THE DESIGN OF INFUSION LESSONS

**Chapter 1: What is Infusion?**

**Chapter 2: Critical and Creative Thinking in Science**



# CHAPTER 1

## WHAT IS INFUSION?

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### Helping Our Students Become Better Thinkers

Improving the quality of student thinking is an explicit priority of current educational reform efforts. Recommendations from groups ranging from education commissions to the nation's governors support this priority and affirm that good thinking is essential in meeting the challenge of living in a technologically oriented, multicultural world.

Although these recommendations have been advanced primarily because of the projected demands of the work force in the 21st century, they also reflect an awareness that knowledgeable thinkers have a better chance of taking charge of their lives and achieving personal advancement and fulfillment. Our students must be prepared to exercise critical judgment and creative thinking to gather, evaluate, and use information for effective problem solving and decision making in their jobs, in their professions, and in their lives.

Making good thinking an educational goal affirms that growth in thinking is obtainable by *all students*. This goal also reflects confidence that *all teachers* can help students to become better thinkers whatever the learning level, socioeconomic background, and culture of the students.

Although textbooks and tests are changing to reflect this aim, it is the classroom teacher who, through day-to-day instruction, must assume the main responsibility for helping our students become better thinkers. The effort that is required to meet this goal must, therefore, be directed at effective classroom implementation. This handbook presents a teacher-oriented approach to improving student thinking that blends sound theory and effective classroom practice and can be used by every teacher.

What does it mean to emphasize good thinking as a major educational goal? Students already use a variety of types of thinking in their personal lives. They compare and contrast when choosing friends. They predict that they will soon eat when they stand in line in the cafeteria. They make numerous decisions in and out

of school every day. They do not have to be taught to do thinking.

Performing such thinking tasks, however, does not necessarily mean performing them *skillfully*. For example, sometimes a person feels inclined to do something and may not think much about it before doing it. A person may purchase an automobile just because he likes the way it looks. Such hasty and ill-considered decisions may lead to disappointing and unexpected surprises, such as high repair bills. In contrast, if we think about many options, search for new alternatives, think about the significant factors in making the choice, consider the consequences of our actions, and plan how to carry out our choice, our decision may be a more effective one. It is *ordinary thinking done well* that is our goal when we "teach thinking."

How can we teach students to improve the quality of their thinking? The thinking skills movement of the '80s produced special programs and emphasized instructional methods to foster thinking. Three principles emerged from these efforts:

- The more explicit the teaching of thinking, the greater impact it will have on students.
- The more classroom instruction incorporates an atmosphere of thoughtfulness, the more open students will be to valuing good thinking.
- The more the teaching of thinking is integrated into content instruction, the more students will think about what they are learning.

These principles provide the basic rationale for infusing critical and creative thinking into content instruction.

Infusion is a natural way to structure lessons. The curriculum is not a collection of isolated bits of information; rather, it is the material that informed, literate people use to make judgments. We expect that information about nutrition should influence students' dietary habits. We expect that an understanding of American political history should affect how citizens vote. We expect that a deep understand-

ing of a character's motivation and actions in a story should inform a discerning reader about his or her conduct and responsibility.

It is, therefore, essential that we teach students how to use information and concepts that they learn in school to make decisions and solve problems effectively. Infusion, as an approach to teaching thinking, is based on the natural fusion of information that is taught in the content areas with forms of skillful thinking that we should use every day to live productively.

### **Improving Student Thinking in Content Area Instruction**

This handbook spells out how we can perform ordinary thinking activities skillfully. Key questions that effective thinkers raise and answer when making sound judgments are organized into thinking plans that can be used to guide good thinking.

The curriculum contains a multitude of natural contexts to teach skillful thinking. Utilizing such contexts, any teacher can design well-crafted infusion lessons that dramatically enhance student content learning.

Kevin O'Reilly, a teacher from the Hamilton-Wenham School District in Massachusetts, introduces a lesson on determining the reliability of sources of information in history by staging a scuffle in the corridor outside his classroom. He then asks student witnesses to describe what happened. He draws an analogy between his students' differing accounts and the variety of accounts regarding who fired the first shot at the Battle of Lexington, the first battle of the Revolutionary War, in 1775. As O'Reilly's students attempt to determine which of the eyewitnesses gave accurate accounts, they reflect on why some historical accounts may be more reliable than others. This reflection arms them with critical thinking skills that they draw on again and again in O'Reilly's classroom. These skills relate to assessing the reliability and accuracy of eyewitnesses, of observation, or of other sources of information—skills of great importance in our lives outside of the classroom.

In the immediate context of studying the Revolutionary War, O'Reilly's students use the skills of assessing the reliability of sources to ex-

amine the context of the battle and the biases that people might have had in describing it. They then make informed critical judgments about the accuracy of various textbook accounts of the Lexington incident. Students who are simply directed to read to "get the facts" typically do not make such judgments about material in their texts. O'Reilly's students gain a deep critical perspective on the role of firsthand reports in constructing a history and learn that histories can be written from different points of view.

Infusion lessons are similarly effective in the primary grades. Cathy Skowron, a first grade teacher at the Provincetown (Massachusetts) Elementary School, uses the same technique to teach the tale of Henny Penny. Many first grade teachers use this story to help students develop listening skills and vocabulary. While fulfilling these language-arts goals, Skowron also uses the story to teach students to think skillfully about the reliability of sources of information. Prompted by her questions, students discuss whether the other animals should have accepted what Henny Penny told them. How can they determine whether Henny Penny is a reliable source of information?

Skowron restructures her lesson by including questions that students might ask about *any* source of information. Raising questions about Henny Penny as a source of reliable information helps them understand the story at a deeper level. They then grasp the "moral" of the story: *hasty, unquestioning thinking can be dangerous.*

Skowron's lesson differs from O'Reilly's in the sophistication of the content, the level of vocabulary, and students' background knowledge. However, both groups of students consider factors that are often overlooked in thinking about sources. They develop strategies for asking and researching the relevant questions about reliability. Between Skowron's first grade and O'Reilly's ninth grade, Skowron's students have plenty of time to develop more and more sophisticated standards for the reliability of sources. When they get to O'Reilly's classroom, in fact, they may already have considerable sophistication in judging the reliability of both primary and secondary sources, and in applying these skills to a variety of content areas

across the curriculum. O'Reilly's job will be to build on and reinforce this prior learning. This will take less class time than would be needed if he were introducing students to this skill for the first time in their educational careers, and may allow for much more sophistication of his approach to the study of American History than is usually possible with ninth-grade students.

If students have not been exposed to this kind of instruction before the secondary grades, however, it is incumbent upon secondary school teachers to introduce students to these skills as soon as possible. Skillful evaluation of sources can be taught, reinforced, and elaborated in many contexts, subjects, and secondary grade levels besides O'Reilly's ninth-grade classroom. When students are asked to do library research and then write on a topic, for example, teachers can ask them to compare a variety of books and articles on the topic in the library, and then to develop a list of questions they would need to answer to decide which sources are likely to give them accurate information on that topic. The students would consider relevant factors, such as the date of the publication, the expertise of the authors, whether the account is primary or secondary, whether the account is fictional, where the author got his or her information, etc. These questions can then be put in a more organized way and written down so that they serve as a guide to the students' thinking.

Based on the information they gather to answer their questions, students then make critical judgments about which of the book(s) being considered are likely to provide the most accurate information. Usually, when students make such judgments, their interest in the topic is enhanced, and better research projects result. Equally important, however, is that, as in O'Reilly's classroom, such students develop a strategy that they can use again and again to make informed judgments about the reliability of other sources of information.

The same content material can be used to teach other critical thinking skills. For example, Skowron introduces causal reasoning by prompting her students to think about whether Henny Penny had good evidence that the sky was falling. Could something other than falling

sky have caused the bump on Henny Penny's head? How could we find out? In general, what do we ask in order to find out what caused something to happen?

*Causal reasoning*, a fundamental skill of inference, involves considering a cluster of questions different from those involved in thinking about reliable sources. These questions prompt consideration of which possible causes are reasonable in light of the evidence. Asking and carefully answering these questions contrasts with hasty and ill-informed judgments that people often make about what caused something.

Skowron's students engage in causal reasoning by thinking about what evidence they would need to tell what really hit Henny Penny. The students then look at the pictures in the book for clues to determine what the cause might be. They contrast *careful* thinking about causes with Henny Penny's quick conclusion that the sky is falling, identifying her thinking as hasty thinking. They use the term "Henny Penny thinking" to describe someone who jumps to a conclusion about causes. This reminds them not to do the same thing but, instead, to look for evidence. Helping students think skillfully about causes in the primary grades can make this kind of thinking second nature as they progress through upper elementary and secondary school.

Secondary school teachers will find ample opportunities to introduce causal reasoning in what they teach. The causes of the Civil War, the events leading up to the stock market crash in 1929, the extinction of the dinosaurs, the ability of jet aircraft to take off and fly, and the poor (or good) performance of the school's football team are topics that can all generate lessons in which students not only gain a deep understanding of these events, but also learn strategies (that they can use repeatedly) for making well-informed judgments about causes. The secondary curriculum is replete with such contexts.

Causal explanation lessons can also be used in secondary school to introduce some of the more challenging themes that students study. For example, causal reasoning also clarifies human motivation and action. Questions like "What was Huckleberry Finn's motivation in

not turning in Jim?” can generate lessons designed to help students learn how to use causal reasoning to answer them. Building on such activities, causal reasoning also helps us to determine the responsibility for things people do. Cathy Peabody, a high school English teacher in Groton, Massachusetts, asks her students causal questions (similar to the type asked by Cathy Skowron) as they study *Romeo and Juliet*. She recognizes in this play that chance, emotion, misunderstanding, and deliberate intent weave a tragic causal web that raises important questions about responsibility.

Specifically, Peabody helps her students spell out the causal chain that led to the deaths of Romeo and Juliet by helping students to identify possible causes of the tragedy and then to select the best explanations based on evidence in the text. Recognizing that various people played a role in this causal chain, Peabody poses the question, “Who, if anyone, is responsible for the deaths of Romeo and Juliet? The feuding parents? The Prince? Friar Lawrence? The lovers themselves? On what basis do we hold people responsible for things that happen?”

Through a detailed examination of the play, informed by their conclusions about the causes of the tragedy, Peabody and her students raise, and try to answer, such deep questions about responsibility. They develop an explicit set of standards that enables them to make a well-supported judgment about who should be held responsible. Some students, for example, think that Friar Lawrence should be held responsible. They then stage a “trial” of Friar Lawrence to determine whether he should really be held responsible for this tragedy. When they reach their conclusion, Peabody helps them extract the standards they used to judge the friar’s responsibility. There is no substitute for careful thinking to answer questions like these.

When such activities are completed, Peabody usually helps her students see analogies between issues in the play and issues in their own experience in which questions of blame and responsibility have arisen. Peabody helps her students test their ideas about responsibility by applying them in these personal cases. Her intention is to expose them to this kind of

thinking and to help them to transfer and use it reflectively in a variety of appropriate contexts.

Thinking carefully about causes is crucial in almost every profession. Effective work in science, engineering, accounting, journalism, nursing, and law enforcement, for example, involves the need for well-founded judgments about causes. This kind of thinking is also crucially important in our daily lives. We make judgments about causes in getting to work on time, preventing or treating illness, preparing a tasty meal, and minimizing stress in our lives. Helping students transfer the use of skillful causal explanation to these contexts enriches any infusion lesson on causal explanation.

These examples demonstrate how the infusion of key critical thinking skills into content learning adds richness and depth to the curriculum. These examples are representative of a multitude of other lessons that are designed to help students develop a wide range of additional thinking skills and processes. This handbook provides the basic tools for such lessons.

## **Thinking Skills and Processes Featured in this Handbook**

The types of skillful thinking we discuss in this handbook form a core of important thinking skills that cut across the various content areas. They fall into the three main categories: skills at generating ideas, skills at clarifying ideas, and skills at assessing the reasonableness of ideas. Generative skills are creative thinking skills: they stretch our thinking and develop our imaginations. Skills of clarification involve analysis: they enhance our understanding and the ability to use information. Skills at assessing the reasonableness of ideas are critical thinking skills: they lead to good judgment. Both examples discussed so far fall into the category of skills at assessing the reasonableness of ideas.

When we engage in natural thinking tasks, these skills of good thinking are rarely used in isolation. Many thinking tasks that we face in our lives or professional work involve decision making and/or problem solving. Thinking skills from each of the three categories blend together for thoughtful decision making and problem solving. We should try to generate original so-

lutions to problems; we should base our decisions on relevant information; and we should assess the reasonableness of each option to select the best one.

These broader thinking processes are also discussed in this handbook. The strategies we present for skillful decision making and problem solving provide the link between the more circumscribed thinking skills that appear in each of the three categories and the authentic thinking tasks students must engage in both in and out of school.

The outline in figure 1.1 shows the thinking skills and processes featured in this book.

In figure 1.2 (page 7), these thinking skills and processes are shown within the more comprehensive context of the thinking domain.

Figure 1.3 (page 8) shows how various thinking skills from each of these categories are combined in decision making.

Teaching the thinking skills of clarification, creative thinking, and critical thinking without helping students learn how to use them in decision making and problem solving accomplishes only part of the task of teaching thinking. Teaching strategies for problem solving and decision making, without teaching students the skills needed to use these strategies effectively, is similarly limited. If we teach lessons on individual thinking skills *and* lessons on decision making and problem solving, we can show how these thinking skills are connected with good decision making and problem solving. Students will then have the thinking tools they need to face their most challenging tasks in using information and ideas.

**The Structure of Infusion Lessons**

Infusing critical and creative thinking into content instruction blends features of two contrasting instructional approaches to teaching thinking that educators have taken: (1) direct instruction of thinking in noncurricular contexts and (2) the use of methods that promote thinking in content lessons.

Infusion lessons are similar to, but contrast with, both of these types of instruction. The diagram in figure 1.4 (page 8) represents this triad.

The *teaching of thinking* by direct instruction means that, in a time period designated for

thinking instruction, students learn how to use explicit thinking strategies, commonly guided by the teacher. Such lessons employ the language of the thinking task and procedures for doing it skillfully. Usually the *teaching of thinking* occurs in separate, self-contained courses or programs with specially designed materials and is taught outside the standard curriculum. For example, students are guided in using the terms and procedures of classification to classify but-

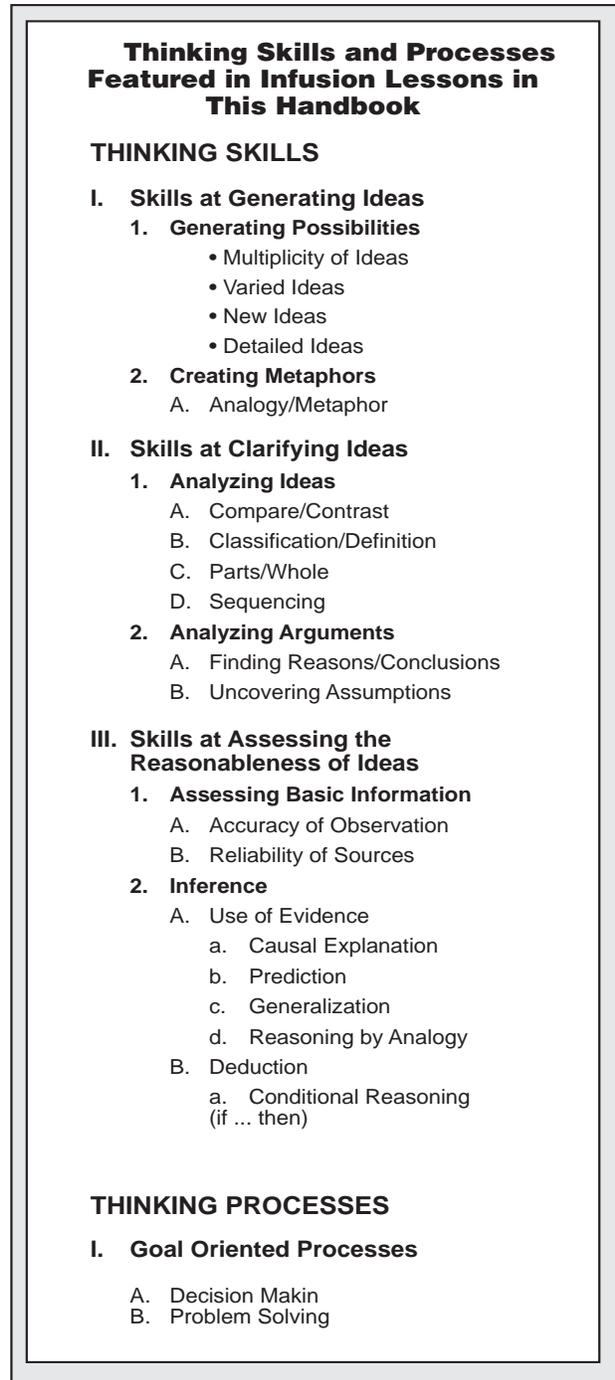


Figure 1.1

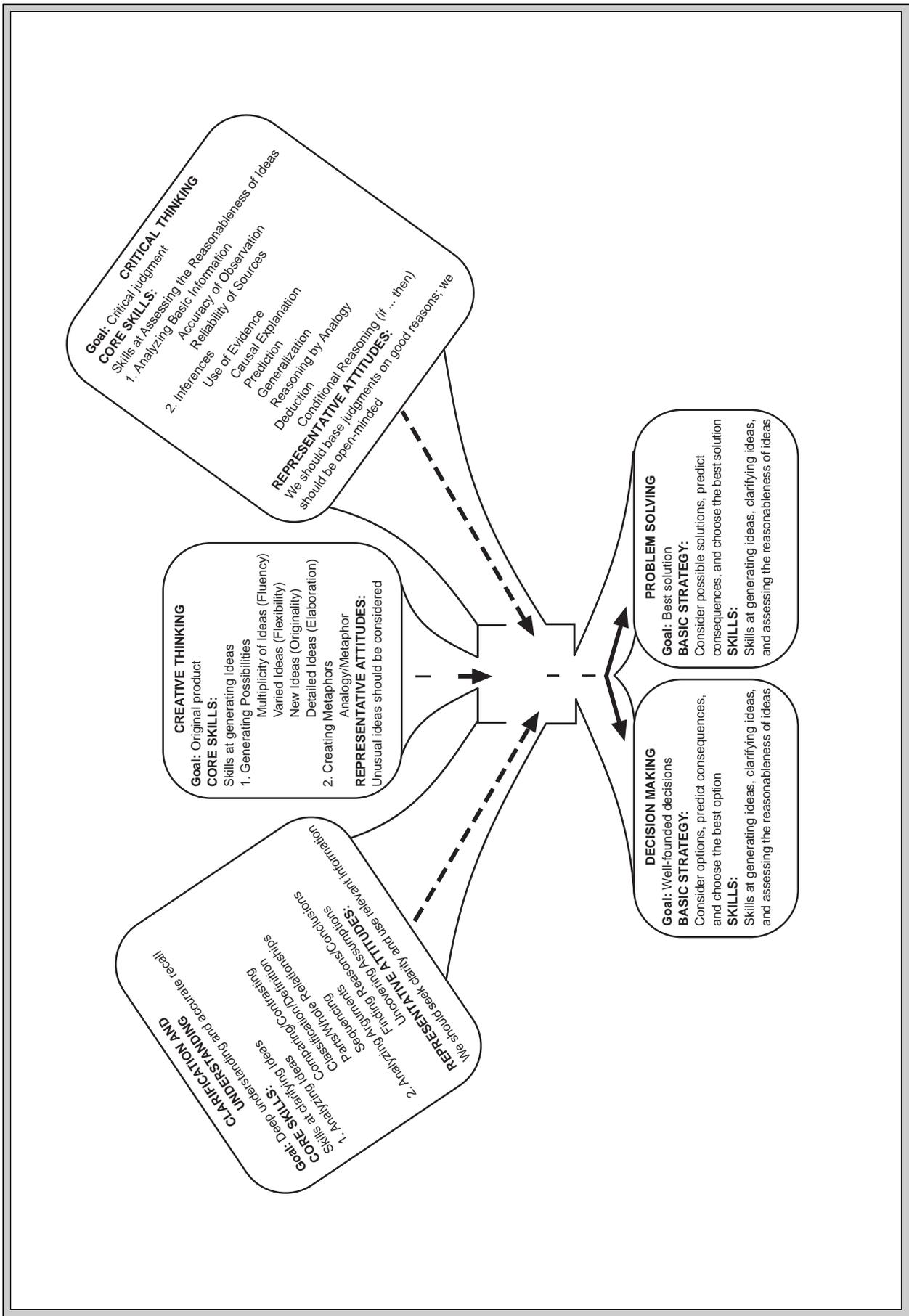


Figure 1.2

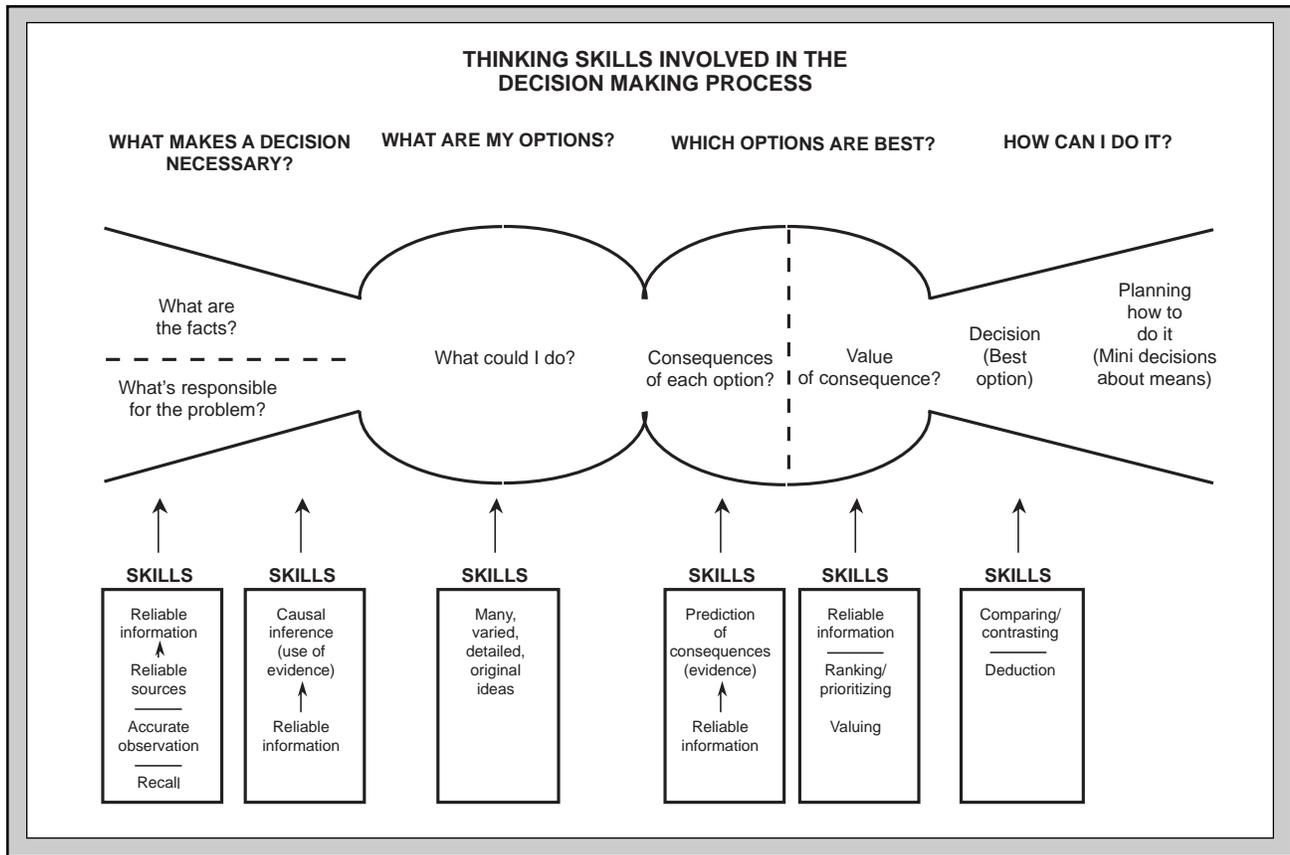


Figure 1.3

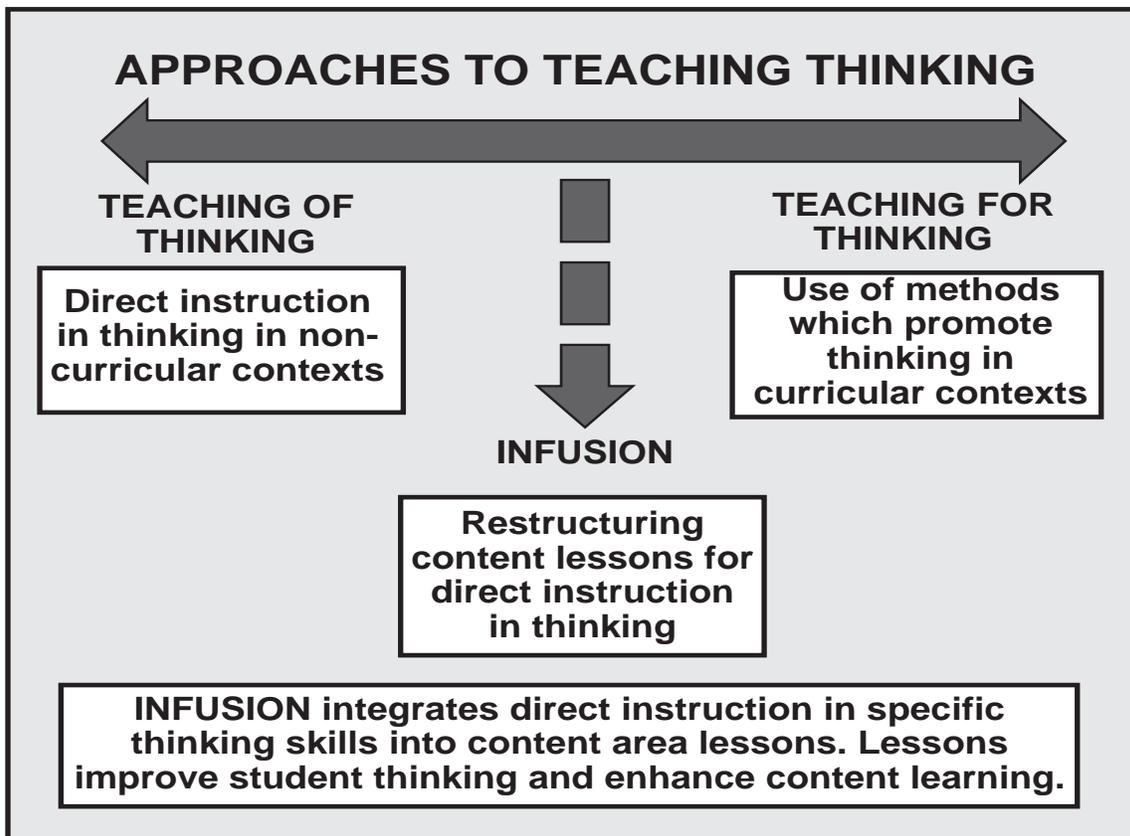


Figure 1.4

tons, to demonstrate and practice the thinking skill, or they are asked to assess arguments from text books on critical thinking, to practice skills in logic. Since the skills are taught using examples that are not curriculum-related, they must then be bridged into the curriculum if students are to apply them to content learning.

In contrast to this approach, infusion lessons are not taught in separate courses or programs outside the regular curriculum. They do, however, employ direct instruction in the thinking skills and processes that they are designed to improve. In infusion lessons, direct instruction in thinking is blended into content lessons.

*Teaching for thinking* involves employing methods to promote students' deep understanding of the content. Such methods include using cooperative learning, graphic organizers, higher order questioning, Socratic dialog, manipulatives, and inquiry learning. While students may respond thoughtfully to the content, no thinking strategy is taught explicitly. In contrast, although infusion lessons also feature such methods, infusion lessons are characterized by direct instruction in thinking skills and processes.

Educators often confuse infusion with using methods that promote thinking. For example, many teachers employ "higher order questioning" or "Socratic dialogue" to stimulate more thinking about the content than asking standard recall-oriented questions. They typically ask "Why," "What if," and "How" questions. For example, a question like "Why did the plague spread so rapidly in medieval Europe?" is a challenging question and unlike the question "What were the dates of the plague in medieval Europe?" provides an opportunity for higher order thinking.

This kind of questioning, however, remains content-oriented. Its goal is usually to yield a deeper understanding of what is being taught. When students respond by mentioning factors like lack of sanitation or lack of medical knowledge, teachers usually ask students to elaborate so that the class can develop a rich understanding of conditions that could cause such an epidemic. The product (student answers), rather than the process (student thinking), is the focus in these lessons.

Typically, when using such methods as higher order questioning, teachers spend little or no classroom time discussing the thinking students engage in when they respond to such questions. *How* students arrive at their responses remains implicit. Some students may respond thoughtfully; others may respond hastily and unsystematically. Some students may not respond at all. In order to yield more thoughtful responses from more students, teachers must take time to clarify the skillful thinking needed to develop thoughtful responses to the questions asked.

Infusion lessons are crafted to bring into content instruction an explicit emphasis on skillful thinking so that students can improve the way they think. Classroom time is spent on the thinking skill or process, as well as on the content. Infusion lessons feature a variety of effective teaching practices that characterize the way thinking is explicitly emphasized in these lessons:

- The teacher introduces students to the thinking skill or process by demonstrating the importance of doing such thinking *well*.
- The teacher uses explicit prompts to guide students through the skillful practice of the thinking as they learn concepts, facts, and skills in the content areas.
- The teacher asks reflective questions that help students distance themselves from what they are thinking about, so they can become aware of how they are thinking and develop a plan for doing it skillfully.
- The teacher reinforces the thinking strategies by providing additional opportunities for students to engage in the same kind of thinking independently.

Conducting a lesson using this four-step strategy to teach thinking is time well spent and will maximize our chances for real improvement in student thinking.

To summarize: Although some people use the word "infusion" only to describe the techniques used to promote higher-order thinking about the content material, what we have been calling "infusion" lessons are also crafted to bring into content instruction *an explicit emphasis on skillful thinking*, together with the use of such thought-provoking methods, so that such lessons maximize