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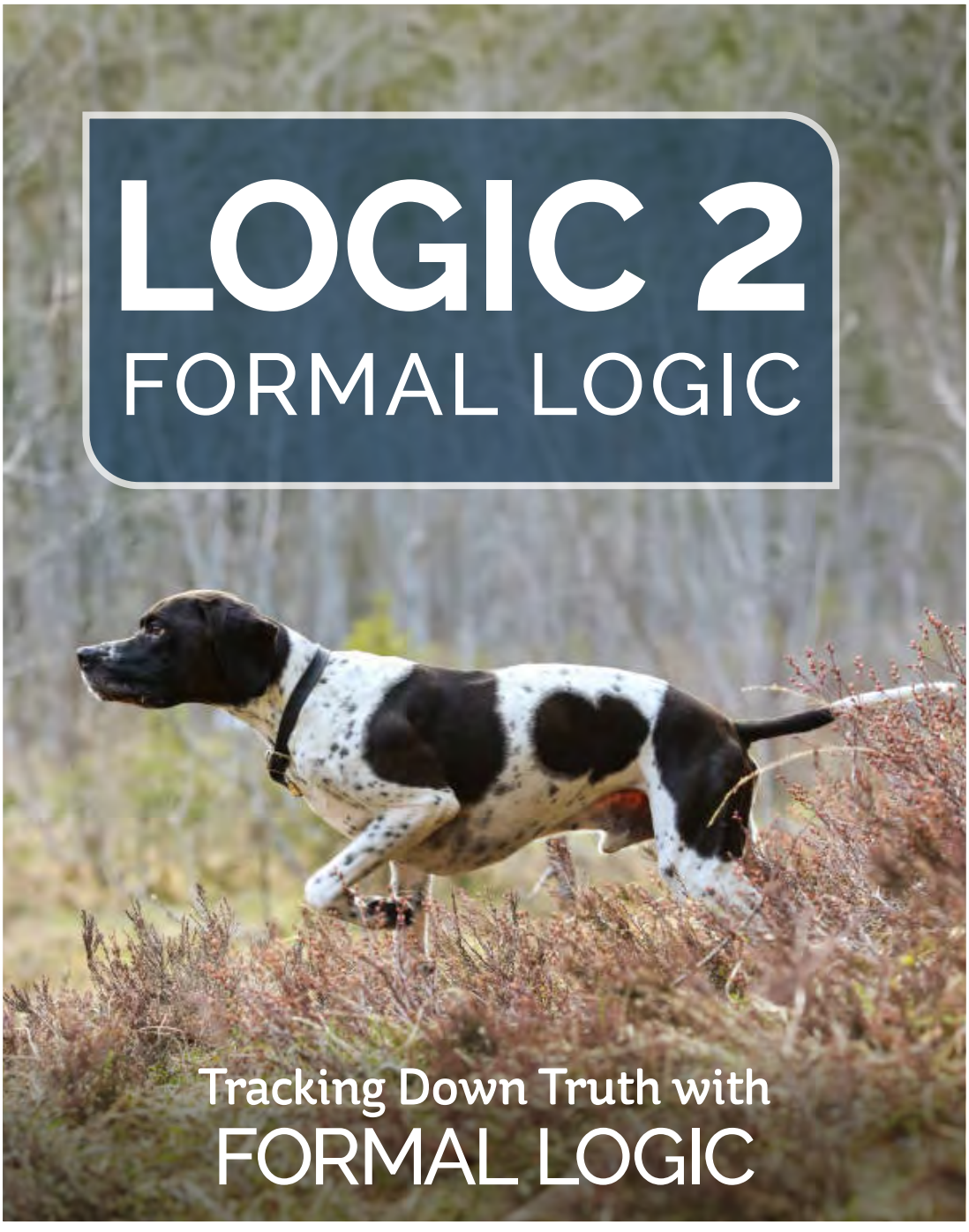
LOGIC 2
FORMAL LOGIC



MICHAEL G. EATMON
CINDY M. FELSO

TEACHER'S EDITION

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FORMAL LOGIC

Tracking Down Truth with
FORMAL LOGIC

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How to Use the Teacher's Edition

Logic 2 aims to teach young adults how to think in better ways so that they may think better things. It offers them basic tools for sound reasoning and clear communication. This course aims to teach students how to argue, as well, but to do so with equal parts honesty and humility. Conversations today too often lack both thoughtful care and careful thought. *Logic 2* strives to set a better course, both through its instruction and by its example.

We hope, though, that *Logic 2*'s high aspirations don't frighten students—or teachers—away! This course aims for lofty heights, but it hopes to get its readers there with careful assistance. It treats its topics with a plain approach and its readers with a playful tone. When possible, it simplifies complexity, and when helpful, it scaffolds the learning process. This incremental approach is vital when covering categorical and propositional logics and debate. It's crucial when covering them in middle school.

The volume before you is a teacher companion to *Logic 2: Formal Logic.* (Most often, we'll refer to the current volume simply as the "TE.") The TE gives guidance and suggestions for how to use the student text and workbook. (Throughout the TE, we'll refer to the student edition as the "SE" and the workbook as the "WB.") The TE's plans, notes, sample responses, and assessments inform and advise.

This teacher edition should be viewed as a teaching companion, though, not as a cookbook. It's not a collection of recipes that need nothing more than water and a whisk. Instead, you'll need to give of yourself, too. You'll need to invest attention, preparation, and reflection.

Some who teach logic have studied the subject before. Many haven't. This teacher edition assumes no prior knowledge of the subject. It does assume, though, teachers will read SE chapters and WB exercises before students do.

We enjoyed putting this teacher edition together for you. We hope you'll find it useful. We hope you'll find ways to build upon it, too. Be encouraged to adapt it to your and your students' needs.

TE chapters' basic pattern

Logic 2 aims to connect today's middle-school audience to a rewarding but complex topic. It aims to do so with the least frustration, too. To achieve that goal, TE chapters follow a basic design.

1. Each chapter in the TE pairs with the same-numbered chapters in the SE and WB. For example, TE chapter 19 pairs with SE chapter 19 and WB chapter 19.
2. Each TE chapter represents a week's worth of instruction. Further, each TE chapter's instruction is divided into five sessions. Some teachers will cover a chapter—five sessions' worth of material—in five days. Some will compress the same material into fewer days. What's most important is to cover all content in each chapter.

- For classes that follow a five-day schedule, a chapter's five sessions will fit like hand in glove. Not all classes will follow a five-day schedule, though. Appendix A shows how to plan lessons for a five-day schedule and a two-day schedule.

3. Each TE chapter follows a pattern (below under 4) for when to complete its content. Teachers shouldn't view this pattern as a mere suggestion, but as a strong recommendation. Completing content when called for is essential to a TE chapter's integrity and flow.
4. Most TE chapters' sessions should follow the pattern below. (TE chapter 1's sessions are exceptions. See chapter 1 itself for lesson details.)
    - Session 1 ("S1" below)
        - S1 assumes that students have read the current chapter beforehand, footnotes included. An important part of each *Logic 2* chapter, footnotes should be read, not skipped over. S1 also assumes that students have completed Session 1 in the WB chapter.
            - For WB Session 1's "Terms & Concepts" section, students may stick closely to the definitions given in the SE. Most important, students need to provide satisfactory answers that they'll remember. Session 1's "Big Ideas" questions, however, call for reflection, not just memory. Most big-ideas questions in the WB are answerable in 3–5 sentences.
            - Veritas recommends that teachers collect and grade students' WB responses each week. We recommend that they be collected late in the week, though. What students submit needn't be their first and only passes at the WB questions. Their responses may, instead, reflect what they've learned during the week.
        - S1 calls you to review each section of the SE chapter and ask for summaries. Discuss unfamiliar words, too, especially those in **blue**. Invite and answer questions of basic comprehension. Be encouraged to discuss any character narrative that appears, also. Then, discuss students' responses to WB Session 1.
            - Some chapters' narratives appear in the SE, some in the WB. Several chapters lack a narrative. Wherever narratives appear, they're an important feature of the text. They illustrate good thinking and bad, strong character and character that needs work.
        - S1 calls for students to complete WB Session 2 for homework. Try to avoid introducing WB exercises in class before they've been done for homework. We want students to tackle the discussion/demonstration questions on their own first.
    - Session 2 ("S2")
        - S2 calls you to finish any helpful discussions from the previous day. Then, discuss students' responses to WB Session 2.
        - S2 calls for students to complete WB Session 3 for homework.
    - Session 3 ("S3")
        - S3 calls you to finish any helpful discussions from the previous day. Then, discuss students' responses to WB Session 3.

    - S3 calls for students to complete WB Session 4 for homework. This includes both the Quiz and the Discussion/Demonstration questions. A short, simple quiz is a staple of all WB Session 4s. The quiz is designed to check basic comprehension of terms, concepts, and skills. Quizzes aim to be straightforward, not tricky.
- Session 4 ("S4")
    - • S4 calls you to collect students' quiz answers at the beginning of class. (Sample responses at the end of each TE chapter show correct quiz answers. We suggest giving each question equal grading weight, unless indicated otherwise.) Finish any helpful discussions from the previous day. Then, discuss students' responses to WB Session 4's Discussion/Demonstration questions.
    - S4 directs students to read and think about WB Session 5 for homework. They'll write their response to it during Session 5's class period.
- Session 5 ("S5")
    - S5 is a class period for students to work on their own. They should use the time to complete WB Session 5's Puzzles & Perspectives. They may use some of the time to review the current or past chapters, as well.
    - S5 calls you to collect students' homework for the chapter, Sessions 1–5, at the end of the day. Define "day" as best suits your purposes.
    - S5 calls for students to read the next chapter in the SE and complete that WB chapter's Session 1.

5. All TE chapters include sample WB responses to all exercises. Doing all discussion/demonstration questions in Sessions 2–4 may be a lot for some students. No worries if so. Feel free to omit a question here and there as helpful. Another approach is to designate some questions as "QPs." These are questions students are expected to ponder and to be prepared to discuss in class. Students needn't respond to QPs in writing, though.
6. Each TE chapter includes detailed teacher notes that pair with the SE and WB. Notes are interspersed among Sessions 1–4. This arrangement is a mere suggestion. Feel free to use whatever notes you wish as best suits your teaching purposes. Some notes clarify core content or call attention to SE subjects needing emphasis. (You'll notice that some teacher notes begin with a quote. Those that do are quoting from the SE chapter.) Other notes invite in-class discussions of important topics not covered in the SE. A third category of notes helps prepare students for WB exercises. Whatever their focus, the notes offer added insight for teaching the course material.

Student work

Student notebooks

The reference material in the back of the SE contains helpful overviews of some of the book's main ideas. (It also contains a helpful overview of several main ideas from *Logic 1: Informal Logic*.) What students won't find there, though, is a glossary of important terms. Important terms appear in blue typeface throughout the SE, and each is defined in context. Still, it may be helpful for students to maintain a notebook for special terms and concepts.

It can be a handy reference that includes definitions, notes, questions, and comments.

That notebook can also function as an overflow location for students' WB responses. One way to organize the overflow section of their notebook is like this. Let's say a student needs more space to write an answer for Big Idea 1. She can start her answer in the workbook and then continue her answer in her notebook. She can label her entry "C1 S1 B1." Other notebook overflows could use a similar abbreviated labeling pattern. For example, an overflow for Chapter 1 Session 2 Discussion/Demonstration 3 could be labeled "C1 S2 D3." Organizing overflow answers in this way helps students become better young logicians. It sharpens their attention to order and detail.

Guidelines for grading WB exercises

No two students, no two classes, no two iterations of the same course are ever identical. Nor are all types of questions the same. Some are more objective ("What's deduction?"). You'll find these kinds of questions in Session 1's "Terms & Concepts" and Session 4's quiz. Some questions are more subjective ("What do you think is meant by 'strong mind'? What about 'teachable heart'?"). You'll find such questions in "Big Ideas," "Discussion/Demonstration," and "Puzzles & Perspectives." Parts of those questions' answers can be considered true or false, right or wrong. Much of their answers' content calls for grading latitude, however.

It's reasonable, then, to view grading guidelines as illustrative but flexible. They'll work for many classroom situations, even if not for all. Adjust grading criteria or evaluation weights as helpful. We do recommend that teachers insist on two requirements, though. One is that students answer definition- and discussion-type questions in complete sentences. The other is that students try to answer questions to the best of their ability. This is difficult to assess, but we stand behind the recommendation.

At the end of each TE chapter, you'll find sample WB responses from a "typical middle-schooler." We use quotation marks because adults wrote all sample responses in the TE. Bear that in mind as you review student work. Attached to each section of sample responses, you'll see a suggested point-value. To get a grade for each WB chapter, you might add up all points earned and divide by the total points possible. That ratio can easily be turned into a percentage, of course.

Supplemental tests and midterm & final exams

Appendix B provides several evaluations: a midterm, a final, and four supplemental tests. The first 15 questions of each evaluation follow the same pattern. They ask for definitions/descriptions of important terms and concepts. Following them in each evaluation are discussion/demonstration questions. Each section of the exams shows questions' suggested point values.

The midterm and final exams have two extra sections that the supplemental tests don't. After their discussion/demonstration questions, each includes 15 items of straightforward matching. After that comes The Bigger Picture, a question that explores a key topic in greater depth.

We see benefit to showing students the first 15 questions in advance of any evaluation. The aim of these questions is to confirm students' comprehension of core content. Assessing memory of chapter content is important. Assessing comprehension of it is more so.

Chapter 1 Plan

WHERE THE RUBBER MEETS . . . THE SEA

In this and all future chapters, we'll use abbreviations for Logic 2*'s three components. We'll refer to the student textbook as "SE," the workbook as "WB," and the teacher edition as "TE."*

By the end of this chapter, students will understand

- what logic is.
- how formal logic differs from informal.
- how formal logic helps us discover and communicate truth.
- that formal logic helps us assess whether an argument is logical.
- that deductive reasoning claims that its conclusions are guaranteed.

Session 1

Before class

For teachers who require students to complete a course assignment before the start of school: Students should have read SE chapter 1, footnotes included, before the first day of class. An important part of each *Logic 2* chapter, footnotes should be read, not skipped over.

For teachers who* do not *require students to complete a course assignment before the start of school: Although unused on day 1 of the course, "Before class" is a regular Session 1 section.

During class

For teachers who required students to complete an advance assignment: Review (but no need to reread) each section of the chapter as a chunk. Ask for summaries. Review any unusual or special terms, especially those in **blue**. Invite and answer any questions about basic comprehension.

For teachers who* did not *require students to complete an advance assignment: Because this is the first day of class, read together SE chapter 1 and its footnotes. (An important part of each *Logic 2* chapter, footnotes should be read, not skipped over.) Read each section of the chapter as a chunk. Pause after each to have students interact with what was read. Ask for summaries. Review any unusual or special terms, especially those in **blue**. Invite and answer any questions about basic comprehension.

All that follows in this chapter is for* all *teachers: Before discussing a chapter in class, be sure to have read it thoroughly yourself. Be sure to have read through the corresponding exercises in the WB, too. Try to avoid introducing the WB's exercises in class before they've been done for homework. We want students to tackle the Discussion/Demonstration questions on their own first.

You and the students may have found something unexpected at the start of chapter 1. Like many chapters, chapter 1 contains a conversation between fictitious characters. In chapter 1, those characters are siblings Renny and Jen and their parents. In chapter 2, we'll meet Renny's best friend, José, and their logic teacher, Mrs. Sagewright. Together, Renny and José are the book's main characters. Later chapters introduce Mama Sagewright, Professor Mentchurn, and Chris LeClair. Wherever narratives appear, they are an important feature of the text. Be encouraged to discuss them.

The notes below may prove helpful for discussing the character narrative.

- The narratives in *Logic 2* build on characters from *Logic 1*. Those unfamiliar with Renny, José, Mrs. Sagewright, and the rest may want to pick up a copy of *Logic 1*. Readers will find much more than stories about two middle-school boys and their logic teacher, of course!
- For chapters that contain narratives, feel free to have students act them out if time permits. Each narrative connects to a topic in logic or philosophy. The TE's teacher notes call attention to some of those connections. The narratives highlight admirable, and not so admirable, attitudes and behaviors, too. Be encouraged to call attention to what's commendable in the characters and what isn't.
- "Real sushi isn't plastic, and plastic sushi shouldn't look real!" Let's tease out the ethical argument Renny is implying, or at least hinting at. (An *ethical argument* is one that makes a case for or against the rightness of some action. Ethical arguments' claims tend

to use words like *right/wrong, should/should not,* or similar.) "If an inedible substance looks like edible food, then a restaurant shouldn't set it out on display. Doing so is inherently deceptive. What I just put in my mouth was an inedible substance that looked like edible food. Therefore, the restaurant shouldn't have set it out on display." Renny's thinking pattern here is logical, but his mom points out a problem with one of his premises. The restaurant had a good reason not to use real sushi in the display case. Renny's misguided reasoning illustrates a fundamental truth about arguments. No matter how good a thinking pattern is, a false premise can't guarantee a true conclusion.

- The exchange about fake sushi anticipates a theme we'll encounter time and again. "Arguments, like men, are often pretenders," Plato wrote. Our task is to strive to sort arguments that contend for the truth from those that only pretend to lead to truth. Pretending arguments have one of two problems or both. Their thinking patterns are unreliable, or one or more premises aren't true.
- Although they're often disguised and merely implied, we're surrounded by arguments. For example, take Mom's line "You could've broken a tooth, you know . . . or died!" This is the conclusion to an implied argument, which we might construct as follows. "If one bites into an unknown substance, then one could break a tooth or die. You bit into an unknown substance. Thus, you could have broken a tooth or died." While Mom's first premise is true, its prediction is highly unlikely in the case of a restaurant's display sushi.

The notes below may prove helpful for a discussion of what logic is and what it can do for us.

- The English word *logic* derives from the Greek *logos,* meaning "word," "discourse," or "reason." Ancient Greek philosophers Plato and Aristotle made much use of the term. John the Apostle made significant use of the term, too, in the Gospel that bears his name. There, he refers to Jesus as the divine *Logos.*
- For a statement to be *true,* "what it says must reflect what *is.*" This description of a *true* statement connects two of philosophy's three core areas of study. It links what we *know* to what's really *real.* (Philosophy's third core area of study focuses on the difference between right and wrong.)
- "We call logic a science because it can help us discover truth about ourselves and the world. We call it an art because with practice, we can improve our use of logic and its tools." These two sentences give us a helpful way to think of a key difference between an art and a science. We call the study of some subject X a *science* because it can help us discover truth about ourselves and the world. We call the study of some subject X an *art* because with practice, we can improve our use of its tools.
- Thinking patterns that can reliably lead our reasoning to the truth, we call *logical* or *valid.* Those that can't, we call *unreliable, illogical,* or *invalid.* Parts 2 and 3 of this course will say much more about these thinking patterns.

Prepare the students to answer both sections of WB Session 1. For the Terms & Concepts section, focus discussion on the chapter terms in **blue.** For the Big Ideas section, talk about the three ways formal logic differs from informal logic.

- "Studies in logic often divide the subject into two types: formal and informal." The latter branch of logic is the topic of *Logic 1: Informal Logic* by Veritas Press. That course focuses on the philosophy of knowledge, cognitive biases, and logical fallacies. It covers basic skills and ethics of argumentation, too. Reference material in the back of the *Logic 2* SE contains a helpful overview of *Logic 1*'s biggest ideas.
- How does formal logic differ from informal logic? Here's a collected summary from the chapter. "First, formal logic pays most attention to an argument's form, or shape. To a formal logician, what an argument is trying to prove is only of secondary importance. Arguments with particular forms, or shapes, are seen as possessing good thinking patterns." "The second way formal logic differs from its cousin is in the language it uses to talk about arguments. [Formal logic] often uses languages—sets of symbols and rules—that look more like math." "The third important way in which the two types of logic differ relates to how we put arguments together. . . . The kind of reasoning that shows up most often in formal logic, however, is *deduction.*"

For homework

Students complete both sections of WB Session 1. For the "Terms & Concepts" section, students may stick closely to the definitions given in the SE. Most important, students need to provide satisfactory answers that they'll remember. Session 1's "Big Ideas" questions, however, call for reflection, not just memory. Most big-ideas questions in the WB are answerable in 3–5 sentences. Sample student responses to WB exercises appear at the end of each lesson in this TE.

Students may need more space to write their responses than the WB provides. If so, then they may want to dedicate a supplemental notebook/binder to *Logic 2.* One way to organize the overflow notebook is like this. Let's say a student needs more space to write an answer for Big Idea 1. She can start her answer in the workbook and then continue her answer in her notebook. She can label her entry "C1 S1 B1." Other notebook overflows could use a similar abbreviated labeling pattern. For example, an overflow for Chapter 1 Session 2 Discussion/Demonstration 3 could be labeled "C1 S2 D3." Organizing overflow answers in this way helps students become better young logicians. It sharpens their attention to order and detail.

Session 2

During class

Finish any helpful discussions from the previous day. Then, discuss students' responses to WB Session 1, which they completed for homework. (As a reminder, sample student responses to WB exercises appear at the end of the chapter.) After discussing students' responses to WB Session 1, talk through WB Session 2 in class.

The notes below may prove helpful for discussions of arguments and formal logic.

- "When logicians use the word ['argument'], they don't mean a disagreement or a fight. Instead, they mean an attempt to give reasons or supports for some claim, some point of view." Of course, these three meanings of *argument* sometimes overlap. What begins as a disagreement can turn into an attempt to support a claim with reasons. Depending on the attitudes and approaches of the arguers, that attempt can turn into a fight.
- Some students may struggle to grasp what an argument's "form," "shape," or "pattern" is. This may owe, in part, to where the student's brain development is. As a field of study, formal logic rests on abstractions and patterns of thought and language. Abstractions and patterns can be hard for younger students to wrap their head around. What's now blurry in some students' minds, however, will gain hi-res detail in parts 2 and 3 of the course. Students will also learn why we view some argument forms as flawless, others as faulty.
- "'Logical' isn't a synonym for true." This relationship bears repeating time and again. *Logical* doesn't mean *true*. *Logical* means only that an argument follows a reliable pattern of reasoning. Consider the following argument. "All swans are white. Some birds are swans. So, some birds are white." This argument follows a dependable pattern of good reasoning. (Its form is AII–1, which students learn about in part 2.) The argument's conclusion and second premise are both true, but the first premise isn't. Some swans are not white.
- Those with strong skills and intuitions in math and language tend to pick up formal logic faster. That doesn't mean, however, that others can't learn and use its tools. It means only that they may need to invest more time, attention, and patience. Let's encourage and applaud these students' extra efforts.

The following notes may prove helpful in discussing WB Session 2.

- Related to C1 S2 D1, consider asking students about Renny's thinking process. Did his argument about the fake sushi seem reasonable? Did Renny's thinking make an error in logic when he chose to take a bite of the display food? If so, what was that error? In short, Renny's argument had a fine form, but it made an erroneous assumption. He assumed that there was no good reason to put fake sushi in a display case.
- Related to C1 S2 D2, maybe highlight the following statement. "Studying logic, we learn to see the twin importances of a strong mind and a teachable heart." Ask students what they think the chapter means by "strong mind"? What about "teachable heart?" How are these good things? How might studying logic help develop them?
- "Learning to use logic's tools can improve our character, too." This claim in *Logic 2* echoes a claim in *Logic 1*. "If we learn how to use its tools well, logic . . . can help us see the importance of a humble heart and a resilient mind." Learning logic's tools helps us uncover problems both with others' thinking and with our own. It also helps us get more clarity about what we believe to be true and why.

For homework

Students complete WB Session 3.

Session 3

During class

Finish any helpful discussions from the previous day. Then, discuss students' responses to WB Session 3, which they completed for homework. Use the sample workbook answers at the end of the lesson to help shape discussions.

The following notes may prove helpful in talking through students' Session 3 responses.

- Related to C1 S3 D1, invite students to give examples similar to the "spoonbill" argument. Here's one: All foxes are animals. All birds are animals. So, all foxes are birds. Students may not know *why,* but can they see *that* the reasoning fails in this example? Further, can they see that the argument fails even though both premises are true? The conclusion tries to connect the premises in an unwarranted way.
- Related to C1 S3 D2, can students see how using symbols can help us understand and solve problems? Consider a math problem. "How many times does four go into the difference between fifteen and three?" It might take two or three reads of the question just to figure out what it's asking. Now, try this: $x = (15 - 3) \div 4$. Easy-peasy, right? Easi-*er,* anyway.
- Related to C1 S3 D3, now's a great time to talk about a feature of formal logic. Its symbols can seem scary to new students. The symbols tend to lose their scariness, though, once students learn what they mean. Formal logic's symbols are simply shorthand representations of ideas. Take the statement "No crane flies are mosquitoes." Using symbols to stand for "crane flies" and "mosquitoes," we could rewrite the statement as "No C are M." The symbols C and M here are mere shorthands for the two insects, crane flies and mosquitoes. The same principle applies to math. Take the symbols +, –, ×, and ÷, for example. They are mere shorthands for addition, subtraction, multiplication, and division.

For homework

Students complete WB Session 4, both the Quiz and the Discussion/Demonstration questions.

A short, simple quiz is a staple element of all WB Session 4s. The quiz is designed to check basic comprehension of terms, concepts, and skills. Quizzes aim to be straightforward, not tricky.

Session 4

During class

At the beginning of class, students submit their quiz answers. (Students should have completed the quiz as homework after Session 3.) We suggest giving each question equal grading weight, unless indicated otherwise. In the sample student responses at the end of each lesson in this TE, correct quiz answers are given.

Finish any helpful discussions from the previous day. Then, talk through students' responses to WB Session 4, completed as homework. Use the sample answers at the end of the lesson to guide your conversation.

The notes below may prove helpful for a discussion of deductive reasoning.

- What's the easiest way for students to remember what *reasoning* is? The easiest way is to say the word slowly. "Reason-ing" is any attempt to provide reasons to believe that some claim is true. This definition applies to any claim, whether it affirms or denies something. The definition also applies whether the claim turns out to be true or false *in fact.* Here's an example of some less-than-stellar reasoning: "Water boils at 32° F because my sister says it does." Here's some more reasoning, slightly better even if snarky. "Water doesn't boil at 32° F because the real world says it doesn't."
- "The kinds of reasoning that tend to show up in informal logic are induction and abduction." For overviews of these kinds of reasoning, see the reference material in the back of the *Logic 2* SE. There you'll find overviews of cognitive biases and logical fallacies, too.
- The book's discussion about *principles* raises an important question. What can count as a premise in an argument? That's a debated question whose answer touches on philosophy, language, psychology, and other subjects. We won't be settling the debate in an intro course on formal logic.

The following note may prove helpful in talking through students' Session 4 responses.

- Related to C1 S4 D1–3, help students think through deduction's *claimed* guarantee. "If my premises are true," claims a deductive argument, "then so is my conclusion." That claimed guarantee depends on certain criteria being met, however. One, the argument's form must be one that reliably leads from premises to conclusion. And two, the argument's premises must be true. The rest of *Logic 2* will say much more about these criteria. For now, it's enough to know that deduction *claims* its conclusions are guaranteed.

For homework

Students read and think about WB Session 5. They'll write their response to it during Session 5's class period.

Session 5

During class

This class period is envisioned as a day for students to work on their own. They should use the time to complete Session 5's Puzzles & Perspectives. They may use some of the time to review the current or past chapters, as well. At the end of the day ("day" as defined by the teacher), students submit the current chapter's homework, Sessions 1–5.

For homework

Students read SE chapter 2 and complete Session 1 in WB chapter 2.

Sample Workbook Answers

FOR CHAPTER 1

Guidelines for grading

Below, you'll find sample workbook responses from a "typical middle-schooler." For a review of suggested grading guidelines, see "How to Use the Teacher's Edition." Adjust grading criteria or evaluation weights as helpful for your students or situation.

Session 1 • Terms & Concepts (1 pt each)

1. Logic is the art and science of reasoning well.
2. Truth is the quality of a statement that reflects reality.
3. An argument is an attempt to give reasons or supports for some claim, some point of view.
4. Reasoning is what our mind is doing when it tries to justify, or prove, the truth of some statement.
5. An inference is a conclusion reached on the basis of evidence and reasoning.
6. Deduction is a kind of reasoning that claims its conclusions are guaranteed, or certain.
7. A principle is a statement that conveys a fundamental truth about something.

Session 1 • Big Ideas (3 pts each)

1. Formal logic differs from informal logic in three ways. 1) Formal logic is more concerned about the shape or form of the argument than informal logic is. 2) While informal logic uses ordinary language, formal logic uses specialized language that follows sets of rules and uses symbols. 3) Informal and formal logic differ on how they put arguments together. That's because they use different kinds of reasoning.
2. Formal logic can help us discover truth by helping us reason to a certain conclusion. It can help us communicate truth by structuring our arguments in a way easily understood by others.

Session 2 • Discussion/Demonstration (3 pts each)

1. Renny thought two main things: If something looks like sushi, it must be sushi, and if a restaurant puts food on display, you can try it. The problem is, Renny didn't know some important stuff. Just because something looks like food doesn't mean it's real food that's ready to eat. Lots of restaurants use fake food that looks like the real thing to show what their dishes look like, but it's not meant to be eaten. Renny also thought that if the food was on display, he could try it. But that's not how it usually works in restaurants. The food on display is just for looking, not for tasting. So, Renny's thinking made sense to him, but he made mistakes because he didn't know these common rules about restaurants and display food. His mistakes led to a funny situation, but they teach us that just because something looks a certain way doesn't mean it's true, and it's always good to ask or know the rules before you do something!

2. A "strong mind" means being able to think clearly and make good decisions. It's about using your brain to figure things out and not just believing something because someone said it. Studying logic helps you develop a strong mind because it teaches you how to think in an organized and reasonable way. A "humble heart" means understanding that you might not always be right and being willing to listen to others. It's about knowing that you can make mistakes and being ready to learn from them. When you study logic, you learn how to think things through and see different sides of a situation, which helps you be more open-minded. So, studying logic can help you become smarter in how you think (strong mind) and more understanding and respectful of others' opinions (humble heart). These are good things because they help you make better choices and get along with people.
3. Form really matters in a lot of different things, not just in logic.

   Sports: In basketball, soccer, or baseball, the way you throw or kick the ball is really important. If your form is off, the ball might not go where you want it to, or you might even hurt yourself.

   Dancing: If you're in a dance class, your teacher might talk a lot about having the right form. That's because how you hold your body can make the dance look really great or kind of awkward. The form helps you move better and keeps you from getting hurt.

   Art: If you're drawing or painting something, the form of the lines and shapes you make helps the picture look like what you're trying to show. If the form's not right, the picture might look weird or confusing.

   Playing a Musical Instrument: How someone plays an instrument matters a lot. If you're playing the guitar, for example, holding your fingers in the right form helps you hit the notes properly. If your form's wrong, it can sound bad and even hurt your fingers.

   Writing: Even in school when you're writing an essay, the form matters. You've got to have an introduction, body, and conclusion, and if you don't follow that form, your essay might be hard for the reader to follow.

   So form isn't just about being fancy or formal. It's a way of making sure things work right, look good, or sound the way they're supposed to. It helps you be better at whatever you're trying to do!

Session 3 • Discussion/Demonstration (3 pts each)

1. The argument might seem to make sense at first, but if you look at it closely, there's a problem with the logic. The statements:
   - All spoonbills are animals.
   - All waterfowl are animals.

   are both true. Both spoonbills and waterfowl are types of animals. Well, "waterfowl" is a word that describes a whole group of animals. So, the conclusion:
   - Therefore, all spoonbills are waterfowl.

   doesn't follow, even though it's true. It's like saying all cats are animals and all mammals are animals, so all cats are mammals. That last statement is true, but the two previous statements don't prove it logically.

2. Using symbols in formal logic, like using 63 ÷ 9 in the banquet problem, has some big advantages. First, it makes problems easier to understand. By turning a confusing situation into a simple math problem, you can see what you need to do without getting lost in all the details. In the banquet problem, 63 ÷ 9 quickly shows that you need to put 7 people at each table. Second, using symbols lets you focus on the form of the argument instead of getting caught up in the words. It's like a shortcut that helps you see how things are connected without being distracted by all the other stuff going on. In the case of the banquet, expressing the problem as 63 ÷ 9 helps you get right to the point and figure out the answer fast. It's the same in formal logic: using symbols can help you see whether an argument makes sense without getting lost in all the words.
3.

   All dogs are mammals.
   All poodles are dogs.
   Therefore, all poodles are mammals.

   To follow the pattern, I can write it like this:

   All D are M.
   All P are D.
   Therefore, all P are M.

   Here, "D" stands for dogs, "P" stands for poodles, and "M" stands for mammals.

Session 4 • Discussion/Demonstration (3 pts each)

1. The argument says that if something's bad for your health, you shouldn't do it, and since drinking sodas is bad for your health, you shouldn't drink them. But is it really true that sodas are that bad? Here are a couple of reasons why that might not be guaranteed:
   - Not all sodas are the same; some might have less sugar or more natural ingredients.
   - Drinking sodas in moderation might not be harmful; it's only when you drink a lot that could be a problem.

   You said to avoid sodas because they can cause cavities or other health problems. But my reasons show that it might not be a problem if you're careful about what kind and how much soda you drink. So, my final inference is that drinking soda doesn't have to be avoided entirely. You just have to be smart about it, like maybe choosing ones with less sugar or not having them all the time. That way, you can still enjoy a soda without it being bad for your health.
2. The conclusion "Macchiato is not a gecko" is guaranteed because of how the argument is set up. If all geckos are reptiles and Macchiato isn't a reptile, then Macchiato can't be a gecko. It's like saying, "If it's raining, then the ground is wet. The ground isn't wet, so it's not raining." So, the conclusion is guaranteed, but that doesn't mean it's true. If Macchiato really is a gecko, then the statement "Macchiato is not a reptile" would be false, and the whole argument would be messed up. So, the conclusion being both guaranteed and true depends in part on the reasons being true.
3. If the statement that "Macchiato is not a reptile" is wrong and is just a mistake like how a fork looks bent in water, then the truth of the whole argument falls apart. If Macchiato is actually a reptile and we just didn't recognize it, then the conclusion "Macchiato is not a gecko" would

be false too. So, even though deductive reasoning tries to guarantee true conclusions, if something's wrong with the supports, like our senses messing up, the truth of the conclusion isn't guaranteed. Basically, if the stuff we start with is wrong, the ending's going to be wrong too! It's like building a house with weak walls. The house may look good from the outside, but the whole thing might come crashing down!

Session 4 • Quiz (1 pt each)

Term or Phrase	Definition or Description
truth: **G**	**A.** the art or science of reasoning well
logic: **A**	**B.** an attempt to give reasons or supports for some point of view
principle: **E**	**C.** kind of reasoning that claims its conclusions are guaranteed, or certain
argument: **B**	**D.** our mind's attempt to justify, or prove, the truth of some statement
inference: **F**	**E.** a statement that conveys a fundamental truth about something
deduction: **C**	**F.** a conclusion reached on the basis of evidence and reasoning
reasoning: **D**	**G.** a statement that corresponds to reality, that reflects what is

The following arguments use deduction:

2. Mr. Sly must be guilty! He ran from the police, and only guilty people run from the police.
4. No narwhal is a fish, and Nelly is a narwhal. She's certainly no fish, then.

Session 5 • Puzzles & Perspectives (5 pts)

I saw this ad on TV for a brand of toothpaste called "SuperSmile." The commercial shows a bunch of kids smiling and laughing, with super sparkly teeth. Then a voice says, "SuperSmile toothpaste makes your teeth shine bright!" At the end, a big shiny logo pops up with the slogan, "Smile like a superstar with SuperSmile!»

Here's the logical form of the argument from the ad:

- If you want your teeth to shine bright, then you should use SuperSmile toothpaste.
- You want your teeth to shine bright.
- Therefore, you should use SuperSmile toothpaste.

Now, does the logical form make sense? Yeah, it does. If the first two sentences were true, then the last sentence would have to be true, too. If you want shiny teeth (and who doesn't?), and SuperSmile really makes your teeth shine, then it would make sense to use SuperSmile.

But just like the Coke example, whether the argument's message is really true or not depends

on the first two sentences being true. Is SuperSmile toothpaste really the key to shiny teeth? That's a whole different question! It's like the crazy Zorns and Zoobs example. The shape of the argument makes sense, but whether it's conclusion is true or not depends on those first parts being right. So, while the commercial makes sense in how it's set up, it doesn't mean you should totally believe it!

Chapter 2 Plan

ONE THING LEADS TO ANOTHER

By the end of this chapter, students will understand

- how sheer belief differs from justified true belief.
- how entailment works and that it's not always bidirectional.
- how to distinguish semantic entailment from logical entailment.
- that entailment guarantees consequence, not truth.
- how validity and soundness differ.
- that deductive reasoning can guarantee validity but not soundness.

Session 1

Before class

Students should have read SE chapter 2 and completed Session 1 in WB chapter 2. (In all chapters, as a reminder, we use abbreviations for *Logic 2*'s three components. We refer to the student textbook as "SE," the workbook as "WB," and the teacher edition as "TE.")

During class

Review (but no need to reread) each section of the chapter as a chunk. Ask for summaries. Review any unusual or special terms, especially those in blue. Invite and answer any questions about basic comprehension. Try to avoid introducing in class any of the WB's Discussion/Demonstration questions.

Discuss students' responses to WB Session 1, which they completed for homework. Sample student responses to WB exercises appear at the end of the chapter.

The notes below may prove helpful for a big-ideas discussion of what *knowledge* is. Most important is that students can differentiate *justified true* belief from *sheer* belief. Simply

believing that some claim is true doesn't make it true. Nor do we *know* that some true claim is indeed true unless we have good reason to believe it is.

- "What's really real? What's the difference between right and wrong? How can we know things?" These three core questions lie at the heart of philosophy. They also represent three major fields of philosophy: metaphysics, ethics, and epistemology. A study of logic can touch on all three. Using logic, we can learn reliable ways of assessing whether a claim is supported by the evidence. Arguments that make the strongest cases are those whose claims are likelier to be true or right. Once reasonably confident about what's true or right, we can make better decisions about how to live life.
- "To philosophers and logicians, [knowledge] isn't a feeling, a hunch, or a wish." This idea bears emphasizing. The mere feeling, hunch, wish, or belief that some claim C is true is no guarantee that C is true. People often say, "I *know* C is true," when what's more accurate is that they merely *believe* C is true. A sports fan could say, "I just *know* that my favorite team is going to win the ball game tomorrow." That fan *knows* no such thing.
- *Logic 1: Informal Logic* dives deep into what it means to know something. This question is foundational to logic and to the work of logicians and philosophers. Those who teach *Logic 2,* and those who study it, would benefit from a review of part 1 in *Logic 1.* In summary, though, we can say that "*knowledge* is justified true belief." To *know* some X, three conditions need to be met. One, we need to believe that X is true. Two, X must in fact be true. (Determining whether some X is true can be oh-so challenging.) Three, we must have good reason to believe X is true.
- "We appreciate her intellectual honesty, too." Educational settings are rife with those who pretend to know or understand what they don't. Let's create an alternative culture, one that values intellectual honesty. Let's commend students who don't pretend to know or understand some X when in fact they don't.

The notes below may prove helpful for an overview discussion of *entailment.*

- Without entailment, "even simple algebraic problems would stump us forever." Oh? How could we not figure out that $x = 3$ in the equation $9 + x = 12$? Consider how we solve the equation. We subtract 9 from both sides of the equals sign. Then, we reason that $x = 3$ *because* $12 - 9 = 3$. Without entailment, though, that reasoning move wouldn't be available to us.
- The power and importance of entailment can't be overstated. It boggles the mind to consider how many things we know *because we know other things that prove them.* How far back can we line up these dominoes of entailment? What's the first link in the entailment chain? We'll answer that question in chapter 3. For now, can students come up with their own examples of things that "lead to" other things?

To prepare students for WB Session 2, consider in-class discussions of the following.

- Related to C2 S2 D1, have students work a few simple math problems. Have them work them as they would in math class, in a column that shows one step of work per

line. Each line will show a new entailment drawn from the evidence of the previous line. If $x - 5 = 7$, for example, then (on the next line) $x - 5 + 5 = 7 + 5$. The following line would show $x = 12$.

- Related to C2 S2 D3, invite students to make up a few X–Y entailment pairs. Have them check to see whether the entailment is reversible. The X statement entails the Y statement, but how about the other way around? It's important that students understand that X–Y entailment doesn't guarantee Y–X entailment. X and Y *may* entail each other, but they *need* not.

For homework

Students complete WB Session 2. Remember that some students may need more space for their responses than the WB provides. If so, then they may use a supplemental notebook/binder for *Logic 2*. See "How to Use the Teacher's Edition" for a suggestion of how students might keep their notebook/binder organized.

Session 2

During class

Finish any helpful discussions from the previous day. Then, discuss students' responses to WB Session 2, which they completed for homework.

The notes below may prove helpful for discussing semantic and logical entailments.

- Do students understand what *consequence* is? *Consequence* is about what follows from a set of statements or facts. It's a fundamental concept in deduction, allowing us to draw valid conclusions from the info we have.
- Semantics is the study of meaning in language. It explores how words convey specific ideas. Semantics is about understanding the implied meanings behind words' and phrases' definitions. Saying that Jack *won* the game implies that he *played* the game. That's because "winning the game" = "playing the game" + "being victorious." Can students come up with their own examples of semantic entailment?
- "Semantic entailment is a powerful engine, but it is guaranteed to work in only one direction." If X semantically entails Y, then the former statement is *guaranteed* to entail the latter. *Sometimes,* though, the entailment works in *both* directions—X to Y and Y to X. Consider these two statements. X: David is a parent. Y: David has at least one son or daughter. If X is true, then so is Y; if Y is true, then so is X.
- "Sarah and Sally sold seashells by the seashore." Unlike semantic entailment, logical entailment doesn't rely on the meanings of terms. To illustrate with this example, let's swap out "Sarah" and "Sally" for "J" and "K." The logical consequence still holds. Statement X: J and K sold seashells by the seashore. Statement Y: J sold seashells by the

seashore. Can students come up with their own examples of logical entailment?
- When we say that X entails Y, we mean that given the truth of X, the truth of Y follows. It's important to underscore, though, that X–Y entailment doesn't guarantee X's *truth.* In fact, the entailment simply *assumes* X's truth, even if only for the sake of argument.

To prepare students for WB Session 3, consider in-class conversations about the following.
- Related to C2 S3 D1, give students a couple of X–Y statements that show semantic entailment. For example, X: Marcie likes seafood. Y: Marcie likes to eat organisms once living in the sea. For another example, X: Patty is Karl's wife. Y: Karl is Patty's husband. Have students explain how the Y statements are semantic consequences of the Xes.
- Related to C2 S3 D2, give students a couple of X–Y statements that show logical entailment. For example, X: We four friends are 14-years-old. Y: I am 14-years-old. For another example, X: Simone and I didn't go hiking. Y: Simone didn't go hiking. Have students explain how the Y statements are logical consequences of the Xes.
- Some students won't be able to differentiate semantic entailment from logical entailment. In the grand scheme, that's okay. What's crucial, however, is that they can see how an X statement's truth necessitates a Y statement's truth.

For homework

Students complete WB Session 3.

Session 3

During class

Finish any helpful discussions from the previous day. Then, discuss students' responses to WB Session 3, which they completed for homework.

The notes below may prove helpful for discussing what deduction can guarantee and what it can't.
- "Which planet is the largest of the three? Which is the smallest?" Were we to hear this setup and question elsewhere, how many of us would head for a search engine? Notice, though, that no Internet search is needed here, not so long as the given planetary info is accurate. Too often, people rely on outside resources not only for info, but also for *how to think about* the info.
- It's crucial to underscore how entailment works. It doesn't say "X is true, so Y must be true." It says "*Assuming* X is true, Y must be true, as well." Statement X may or may not be true in fact.

To prepare students for WB Session 4, consider in-class conversations about the following.

- Related to C2 S4 D1, invite students to figure out which alien is oldest. "Zorn is older than Korn but younger than Dorn." We know nothing about the aliens' absolute ages; we know only their relative ages. Still, we know enough to answer the question.
- Related to C2 S4 D2, we could standardize the "alien" arguments like this. Premise 1: Zorn is older than Korn. Premise 2: Dorn is older than Zorn. Conclusion: Dorn is the oldest. We can swap the premises' order, too, to make their mathematical relationship clearer. Premise 1: Dorn is older than Zorn. Premise 2: Zorn is older than Korn. Conclusion: Dorn is the oldest.
- We know enough about the aliens to answer the age question but only if the original statement is true. First, the three aliens must exist, whether in reality or in someone's imagination. Second, the statement about their relative ages must be true. If both of these conditions are met, then Dorn is the oldest. Deduction can guarantee that a certain conclusion follows from given premises. Deduction can't guarantee, however, that the premises or the conclusion is true.

For homework

Students complete WB Session 4, both the Quiz and the Discussion/Demonstration questions.

A short, simple quiz is a staple element of all WB Session 4s. The quiz checks basic comprehension of terms, concepts, and skills. Quizzes aim to be straightforward, not tricky.

Session 4

During class

At the beginning of class, students submit their quiz answers. (Students should have completed the quiz as homework after Session 3.) We suggest giving each question equal grading weight, unless indicated otherwise. In the sample student responses at the end of each lesson in this TE, correct quiz answers are given.

Finish any helpful discussions from the previous day. Then, discuss students' responses to WB Session 4, which they completed for homework.

The notes below may prove helpful for discussing deduction—what it can guarantee, what it can't.

- "Assessing for validity ignores the actual truth or falsity of the argument's content." Here's a drum worth beating now and then throughout the course: *valid* doesn't mean *true.* The term *valid* simply indicates that an argument's reasoning pattern is reliable. It's impossible for a valid argument's premises to be true but its conclusion to be false. "Valid" doesn't imply that *any* of the argument's statements is true in fact, though.
- "Master logicians appreciate the power of logic to help lead us to truth. They also

understand that logic alone is rarely enough to get us there." Logic can tell us whether statement X entails statement Y. It can tell us, too, whether an argument is valid, whether its conclusion follows from its premises. What logic can't do is determine whether every claim we encounter is true. "Right triangles have one side longer than the other two." "Humans have opposable thumbs." "Moscow is the capital of Russia." "God exists." Powerful tool as it is, logic alone can't confirm or deny the truth of these statements or countless others.

Consider in-class conversations about the following.

- "Logic is a powerful tool, but it isn't omnipotent." This statement is one of several in this chapter that point out that logic is limited. Try prompting a discussion with the students about things logic can't do. For example, it can't "prove" love, create art, or figure out which spice is missing from the apple pie.
- When describing logic, we often refer to it as a reasoning "tool." Maybe, lead a conversation about how a tool's characteristics apply to logic. For starters, both are specially designed to accomplish a specific task or set of tasks. Both are useful for that task(s), but they're not always so useful for tackling other tasks.

Be encouraged to discuss the character narrative, too. The notes below may prove helpful for a discussion of contradictory statements. That's a topic the SE takes up several times: in chapter 3 and in parts 2 and 3 of the book. For now, we can think of contradictions as statements that cancel each other out. It's enough in this chapter for students to feel the confusion that these statements can bring on. "Are you saying that maybe I'm right that the cow was abducted *and* Renny is right that it wasn't?" What accounts for the confusion we feel in the presence of contradiction? What do students think?

- The narrative's title, "A Tale of Two Truths," alludes to Charles Dickens's novel *A Tale of Two Cities.* Its opening line is one of the more memorable in all of English literature. "It was the best of times, it was the worst of times. . . ." Dickens strings together a series of contrasting, even contradictory, pairs. In the chapter narrative, Mrs. Sagewright sets up her own pair of contradictory statements. If she's trying to teach the boys how to think better, why would she do that? What do your logic students think?
- The UFO discussion reminds us that we can *believe* things without *knowing* them. Invite students to list things they believe to be true but don't know for certain. How about that the sun will rise tomorrow? Or that they are who they think they are? Or that an alien race of reptiles hasn't infiltrated the world's most powerful governments? (Yes, some people believe they have.)
- Mrs. Sagewright asks if both boys could be right. Maybe ask students whether some things are true for everyone, but other things are true only for some? For example, "2 + 2 = 4" is true for everyone. "English is easier to learn than Chinese" is true for some, but not for all.
- Do students agree with José, that he and Renny can't both be right? Do students agree,

further, that it's somehow "not allowed" for a claim to be both true and false at the same time? If that's what students think, then what *makes* that true-*and*-false situation disallowed? That last question gets at the nature of logic's "laws." Are they mere human inventions, or are they discoveries about the nature of reality? What do students think?

For homework

Students read and think about WB Session 5. They'll write their response to it during Session 5's class period.

Session 5

During class

This class period is envisioned as a day for students to work on their own. They should use the time to complete Session 5's Puzzles & Perspectives. They may use some of the time to review the current or past chapters, as well. At the end of the day ("day" as defined by the teacher), students submit the current chapter's homework, Sessions 1–5.

For homework

Students read SE chapter 3 and complete Session 1 in WB chapter 3.

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