Lesson Plan: A Little Logic

**Topic/Question:** Philosophical Logic/How do I reason?

**Age Group:** 7th grade and up

**Time:** about 30 minutes

**Materials:** Eight note cards and the logic puzzle from *Harry Potter and the Sorcerer’s Stone*.

**Description:**

The primary outcome of this group of linked exercises is to show students that they are better at logic than they think they are. As a matter of fact, human beings are naturally good at logical reasoning, just in case there’s something meaningful at stake. That is, when faced with having to use logic to figure out something that makes a difference to our well-being, we generally do a pretty good job.

By contrast, the kind of theoretical puzzles that students typically take on in logic classes or to which younger students are sometimes introduced in math education are made difficult primarily because they are so theoretical. When it doesn’t really matter whether you solve the puzzle or not, the puzzle becomes much harder. Demonstrating to students that when they need to use logic, they can do so with some fluency, helps instill in them a sense of confidence and accomplishment that can end up improving their overall skills in critical and logical reasoning.

The following exercise illustrates this point for students in two parts.

First, share with them the fairly well-known example from Cosmides and Tooby\(^1\) which makes the point that people do modus tollens much better in real-life scenarios than when doing logic puzzles; then give students the Harry Potter logic puzzle to work

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through, which brings home the point about our increased proficiency in logic when something meaningful is at stake.

The Cosmides and Tooby example has two parts. Begin by drawing four “cards” on the board, as illustrated below:

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O
A
B
C
D
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Students are to imagine that the shaded part of the card can slide over to reveal what’s underneath, there might be a circle under it or it might be blank.

Then ask students to consider this claim: *In every case, where there is a circle on the left, there is a circle on the right.* Remind them, though, that they are students, so they want to do as little work as possible. The question they are to answer is: which cards need to have the shaded part revealed to test whether the claim is true? They might have to reveal all the cards, maybe only A, or B, or C, or D, or any combination thereof.

They write their answers down on small slips of paper, which I collect.

Then set up a second example. Get four students to come to the front of the room. Each is given a notecard which he or she holds up. The cards read as follows:

A. BEER
B. SODA
C. OVER 21
D. UNDER 21
Now, tell students they are liquor control board inspectors who have come to this restaurant to see if there is any underage drinking going on. But, as government workers, they want to do as little work as possible, so which patrons do they need to get more information about—related to the patron’s age or what he or she is drinking—in order to test whether anyone is underage drinking?

Again, they write their answers down on small slips of paper, which are collected.

Upon examination of their answers, routinely, this is what happens: In the first example, only a handful of students answer correctly, A & D; in the second example, almost all students answer correctly, A & D.

Now ask, “Why is this? After all, both puzzles were the same.”

(You can fill in this point out by demonstrating, on the board, all the possible combinations of each card and showing that it’s really only A and D which we would be interested in; the same goes for the beer drinker and the underage drinker in the second example.)

Typically, respond answer that the second puzzle was more tangible, that there was something real to figure out, and that since beer was involved, it was more interesting. The first one, by contrast, was just a theoretical puzzle that didn’t have anything to grasp on to.

Lead a discussion, then, about how much better we do with logic puzzles when there’s something at stake. Solicit examples of problems students have solved with the application of logic. For instance, a sixth-grader told me a story about using logic to convince his parents that he ought to be allowed to get a new computer game. They were telling him, he said, that his math grades weren’t good enough and argued that if he got
the new game, he’d continue to do poorly. “But I pointed out to them their mistake,” he said. “Just because IF I got the game, I’d continue to do bad at math, doesn’t mean if I did NOT get the game, I’d do well!” I commended him on recognizing that his parents here committing the fallacy of denying the antecedent and asked him if his strategy worked. “Not exactly,” he said, “but once I brought my grades up a little, they let me buy it anyway.”

Sometimes students will push back a little on the solution to the first puzzle that both “A” and “D” have to be turned over. They will say that you only need to look at “A” because once you see that there’s not a circle on the right, you can stop, since the original question was “Is it true in ALL cases that if there’s a circle on the left, there’s a circle on the right.” This objection can be used to reinforce the main point of the exercise: that when there’s something at stake, we all do better at logic. In this case, those raising the objection feel that they’ve been cheated or duped by the exercise. They are effectively applying logical reasoning to defend themselves against an exercise they think is unfair. Something is at stake—in this instance, their self-esteem or sense of fair-play—and, as a result, they’re more effective than they would be otherwise in applying the rules of logic.

In any case, the discussion of how much better we do with logic when something matters to us leads naturally into the Harry Potter logic puzzle.

Readers of the series will recall that the first Harry Potter book, Harry and Hermione are faced with a challenge in their search for the Philosopher’s Stone. They come across seven potion bottles and have to find out which one will lead them forward
through the fire and which one will take them back to safety. Accompanying the bottles is the following riddle:

Danger lies before you, while safety lies behind,
Two of us will help you, whichever you would find.
One among us seven will let you move ahead,
Another will transport the drinker back instead.
Two among our number hold only nettle wine,
Three of us are killers, waiting hidden in line.
Choose, unless you wish to stay here forevermore,
To help you in your choice, we give you these clues four:

First, however slyly the poison tries to hide
You will always find some on nettle wine's left side;

Second, different are those who stand at either end,
But if you would move forward, neither is your friend;

Third, as you see clearly, all are different size,
Neither dwarf nor giant holds death in their insides;

Fourth, the second left and second on the right
Are twins once you taste them, though different at first sight.

Draw on the board seven “potion bottles,” of different sizes and shapes; the smallest “bottle” is number three from the left; the largest is sixth from the left.
With apologies to real artists, my diagram looks something like this (the “solutions” written underneath the bottles are not included):

Explain to students that with the clues they’ve been given, they should be able to identify what is in each of the bottles. Then set them out to do so.

Usually, a handful of students finish pretty quickly; a good practice is to check their answers and, after confirming that their solutions are correct, ask those students who have successfully completed the puzzle to help students who haven’t finished yet. When everyone is done—or has given up—debrief the exercise.

First, ask one of the students who successfully solved the puzzle to show the class how he or she did so. Typically, different students have different methods, and so we take some time having students show us what they did. It can be informative to compare how some students approach the puzzle very systematically, (often a student will construct a grid or matrix and systematically eliminate options via the clues) while others take a more “seat-of-the-pants” approach. It’s worthwhile to explore whether there is a “best” method or whether whatever works, works.
Eventually, though, a discussion emerges in which the fact that there was something important at stake—in this case, life and death—made students better able to do the logic.

The lesson here is a valuable one, especially for students who tend to think that logic is not their strong suit. Typically, even if students are not convinced that they are better logicians than they think they are, this still leads to an interesting discussion about logic and critical thinking. And the upshot of this is that students tend to be more open to thinking about thinking than they were before, which, above all, is the main take-away of the exercise.