Exploring Leadership

PROBLEM SOLVING: DEDUCTIVE REASONING

Problem-solving skills are necessary in all areas of life, and in order to solve many problems (including but not limited to those in some math classes!) a certain amount of Deductive Reasoning is needed. Using Deductive Reasoning to solve logic puzzles is fun as well as educational, and this activity allows young people to work together while practicing their deductive reasoning skills.

CONVERSATION STARTER:

- Knights always tell the truth. Knaves always lie. There are two people (A and B), a knight or a knave. A says, "At least one of us is a knave." Identify each person as a knight or knave.

Deductive Reasoning is a logical, non-biased way to solve a problem by testing your hypothesis against given facts to see if it is correct. When the hypothesis proves true, the problem is solved. If not, you have to try again. Deductive Reasoning is a requirement in many professions and a valuable skill for a leader.

KEY OBJECTIVES:

- Describe and practice Deductive Reasoning.
- Use Deductive Reasoning to solve a problem.

WHAT YOU'LL NEED:

- Computer/Projector to show video: https://www.ted.com/talks/lisa_winer_can_you_solve_the_river_crossing_riddle/transcript
- Printed transcript (see Appendix)
- Paper and pencils for each group

EXPLORATION ACTIVITIES:

Before starting this video, be sure to watch all the way beforehand to familiarize yourself with the riddle and testing hypotheses.

- Form small groups and show the first 59 seconds of the video.
- Stop on the frame that says "Pause here...". (If video is unavailable, read the transcript in the Appendix for this lesson to this point.)
- Encourage each group to work together. They may draw out their hypotheses on paper, or even act them out physically if space allows.
- Discuss/compare solutions. Let each group present their solution quickly.
- Show the end of the video.
- If time permits, return to the displayed riddle and ask them how they could solve it. What hypotheses do they test? (Answer: *A* is a knight. *B* is a knave. How do we know? Hypothesize: If *A* were a knight, *B* would have to be a knave because knights always tell the truth. If *A* were a knave, he would never make that statement because knaves always lie, so the statement is, in fact, true.)

FACILITATOR TIPS:

- Encourage students to test their hypotheses in a hands-on way: act it out or draw it on paper.
- Resist the urge to just tell the answer, and don't allow participants to cheat by looking it up on their phones.

REFLECTION QUESTIONS:

- Did your group arrive at a correct answer? How did you do it?
- Was this a team effort or was there one person in the group who seemed to "get it" faster than others? What was their secret?
- Name some games or puzzles that involve deductive reasoning? (Battleship, Sudoku, Clue, etc.) Do you enjoy these kinds of mind puzzles? Why or why not?

APPLICATION DISCUSSION:

- When IRL (in real life) would you have to use deductive reasoning and/or hypothesis testing? (When you begin with "If...," you are using deductive reasoning...)
- Share an example of a time you used deductive reasoning to solve a problem.

CONCLUSION:

Deductive Reasoning is a logical, dispassionate way to solve a problem when you understand some of the parameters but not all of them. You test your hypothesis against what you already know to see if it is correct. When the hypothesis proves true, deductive reasoning is very difficult to argue against. That doesn't mean people won't argue with you, but it does mean they will have to have powerful logic on their side to do so. Practice Deductive Reasoning to become a good thinker and problem solver!

REFERENCES

- https://www.ted.com/talks/lisa_winer_can_you_solve_the_river_crossing_riddle/transcript (video)
- https://brilliant.org/wiki/logical-puzzles/
- https://www.transum.org/software/River_Crossing/Level1.asp
- https://www.livescience.com/21569-deduction-vs-induction.html

APPENDIX:

Transcript: As a wildfire rages through the grasslands, three lions and three wildebeest flee for their lives. To escape the inferno, they must cross over to the left bank of a crocodile-infested river. Fortunately, there happens to be a raft nearby. It can carry up to two animals at a time, and needs at least one lion or wildebeest on board to row it across the river. There's just one problem. If the lions ever outnumber the wildebeest on either side of the river, even for a moment, their instincts will kick in, and the results won't be pretty. That includes the animals in the boat when it's on a given side of the river. What's the fastest way for all six animals to get across without the lions stopping for dinner? Pause here if you want to figure it out for yourself.

If you feel stuck on a problem like this, try listing all the decisions you can make at each point, and the consequences each choice leads to. (These are your hypotheses.) For instance, there are five options for who goes across first: one wildebeest, one lion, two wildebeest, two lions, or one of each. If one animal goes alone, it'll just have to come straight back. And if two wildebeest cross first, the remaining one will immediately get eaten. So those options are all out. (Deductive reasoning has helped establish these hypotheses will not work.)

Sending two lions, or one of each animal, can actually both lead to solutions in the same number of moves. For the sake of time, we'll focus on the second one.

- One of each animal crosses. Now, if the wildebeest stays and the lion returns, there will be three lions on the right bank. Bad news for the two remaining wildebeest.
- So we need to have the lion stay on the left bank and the wildebeest go back to the right. Now we have the same five options, but with one lion already on the left bank. If two wildebeest go, the one that stays will get eaten, and if one of each animal goes, the wildebeest on the raft will be outnumbered as soon as it reaches the other side. So that's a dead end, which means that...
- ...at the third crossing, only the two lions can go. One gets dropped off, leaving two lions on the left bank.
- The third lion takes the raft back to the right bank where the wildebeest are waiting. What now? Well, since we've got two lions waiting on the left bank, the only option is for...
- ...two wildebeest to cross. Next, there's no sense in two wildebeest going back, since that just reverses the last step. And if two lions go back, they'll outnumber the wildebeest on the right bank.
- So one lion and one wildebeest take the raft back leaving us with one of each animal on the left bank and two of each on the right. Again, there's no point in sending the lion-wildebeest pair back, so...
- ... the next trip should be either a pair of lions or a pair of wildebeest. If the lions go, they'd eat the wildebeest on the left, so they stay, and the two wildebeest cross instead.
- Now we're quite close because the wildebeest are all where they need to be with safety in numbers. All that's left is for that one lion to raft back and bring his fellow lions over one by one.
- That makes eleven trips total, the smallest number needed to get everyone across safely.
- The solution that involves sending both lions on the first step works similarly, and also takes eleven crossings. The six animals escape unharmed from the fire just in time and begin their new lives across the river. Of course, now that the danger's passed, it remains to be seen how long their unlikely alliance will last.

REFERENCES

- https://www.ted.com/talks/lisa_winer_can_you_solve_the_river_crossing_riddle/transcript (video)
- https://brilliant.org/wiki/logical-puzzles/
- https://www.transum.org/software/River_Crossing/Level1.asp
- https://www.livescience.com/21569-deduction-vs-induction.html