

Using Puzzles to Teach Problem Solving

TEACHER'S GUIDE TO HOPPERS AND FLIPIT

BENEFITS

Hoppers and Flipit are jumping peg puzzles that are exciting ways to teach elements of

- problem solving
- sequential thinking
- logical reasoning

Each game is entirely self-directed, with 40 challenge cards that let students choose their level of difficulty. The activities in this guide will help your students get more out of Hoppers and Flipit by reflecting on their experiences.

ABOUT HOPPERS

Equipment. Hoppers includes 12 playing pieces shaped like frogs, 40 challenge cards with challenges on the front and answers on the back, and a playing board that doubles as a storage container for all the parts.



How to Play . Select a puzzle card and place the frogs in the opening position shown on the front of the card. Your goal is to hop until only one frog is left in the pond.

Frogs move from lily pad to lily pad only along the lines inscribed in the board. On every move you must jump one frog over another frog on an adjacent lily pad, and land on the next pad in the line, which must be empty. When a frog is jumped over, remove it from the board. When only one frog is left, the challenge is solved. The last frog may be anywhere on the board. Frogs may only move by jumping over one other frog, and may not jump over an empty lily pad or land on another frog.

Challenge Cards . Challenges are graded by difficulty: Beginner, Intermediate, Advanced and Expert. The answer to each challenge is printed on the back of the card. Merely glancing at the back of a card will not give away the solution, since it takes work to read the solution notation.

History. Hoppers is based on “The Great 13 Puzzle,” invented in 1899. Japanese puzzle designer Nob Yoshigahara enhanced the original puzzle with a series of challenges, devised with the aid of a computer program.

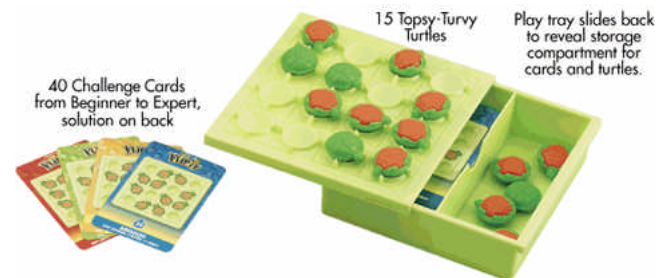
Hoppers vs. Flipit

Hoppers and Flipit are both jumping peg puzzles that exercise sequential thinking skills. Both include a wide range of puzzles from simple to hard.

We recommend you start with Hoppers, which is more basic and has simpler rules than Flipit. Also get Flipit if you want variety, have older students (middle school and up), or want harder challenges. The two games are different enough that both are worth having.

ABOUT FLIPIT

Equipment. Flipit includes 15 playing pieces shaped like turtles, 40 challenge cards with challenges on the front and answers on the back, and a playing board that doubles as a storage container for all the parts.



How to Play . Select a puzzle card and place the turtles upside down (orange side up) in the opening position shown on the front of the card. Your goal is to flip all the turtles from upside down (orange shell side) to right side up (green shell side).

On every move you must move a turtle (either side up) by jumping over one or two neighboring turtles in the same row, column, or diagonal, and land on the next square, which must be vacant. For instance the turtle marked X at right can jump to A or B. The turtles that are jumped over get flipped over (from orange to green, or green to orange). The turtle that does the jumping does *not* flip. No non-jump moves are allowed.

History. Flipit was created by Japanese puzzle inventor Nob Yoshigahara. It was inspired by the game Reversi, invented in England in the 1880s, which also involves pieces that flip over to change color.

INTRODUCING HOPPERS AND FLIPIT

Play the games, reflect on experience

Try it . Have students work through the puzzles on their own either individually or with a partner. Give each student a sheet to record their progress. You will find a blackline master on the next page. A few tips:

- Start with puzzle 1 to learn the rules.
- Work through puzzles in sequence, or skip around.
- Be sure to set up the opening position properly.
- If a puzzle is too hard, try an easier puzzle or remove some pieces and solve just part of the problem.
- If all else fails, dump the pieces off the board and start over, or play through the solution on the back.
- Ask students to write about their thought processes. Which puzzles did they find interesting and why?

Reflect on experience . As with all manipulatives, students will get more out of Hoppers and Flipit if they reflect on their experiences. Ask students to write about:

- Explain the rules of the game in your own words. Show your rules to another student and see if they agree with your explanation. Can other people find loopholes in your rules?
- What problem solving strategies did you try? Which worked well and which did not?
- What did you do when you got stuck? Can you explain through words or diagram the strategies you tried in solving a particular puzzle? It may be easier to record your thoughts if you talk about what you are thinking as you work on a puzzle, and let your partner take notes.
- Write hints for a few puzzles that you found especially interesting. Try your hints on another student and see if they are helpful.
- What general advice would you give to other students trying to solve Hoppers or Flipit puzzles?

Challenge cards for Hoppers, Flipit -

Name: _____

Puzzle	Solved?	Comments, hints
Beginner 1		
Beginner 2		
Beginner 3		
Beginner 4		
Beginner 5		
Beginner 6		
Beginner 7		
Beginner 8		
Beginner 9		
Beginner 10		
Intermediate 11		
Intermediate 12		
Intermediate 13		
Intermediate 14		
Intermediate 15		
Intermediate 16		
Intermediate 17		
Intermediate 18		
Intermediate 19		
Intermediate 20		

Puzzle	Solved?	Comments, hints
Advanced 21		
Advanced 22		
Advanced 23		
Advanced 24		
Advanced 25		
Advanced 26		
Advanced 27		
Advanced 28		
Advanced 29		
Advanced 30		
Expert 31		
Expert 32		
Expert 33		
Expert 34		
Expert 35		
Expert 36		
Expert 35		
Expert 38		
Expert 39		
Expert 40		

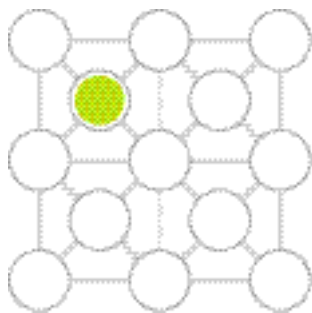
PLAN AHEAD

Game for 2 students on 1 Hoppers board

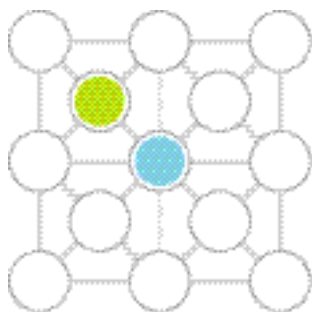
Hoppers exercises sequential thinking. The further ahead you can think, the better you can solve puzzles. After playing Hoppers for a while your ability to imagine moves in advance improves. Here is a game for two players on one Hoppers board that will stretch your ability to plan ahead. The same game works with Flipit, but not as well.



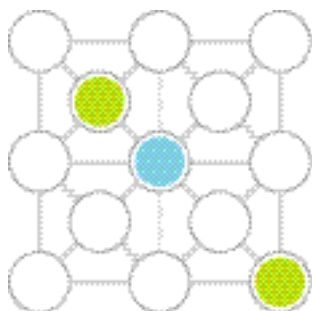
Each player receives 3 frogs. Here player 1 gets green frogs, and player 2 gets blue frogs. Tip: for a harder game, start each player with 4 or 5 frogs.



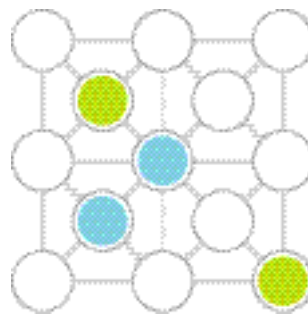
The two players take turns placing frogs on the board. First player 1 places a frog anywhere on the board.



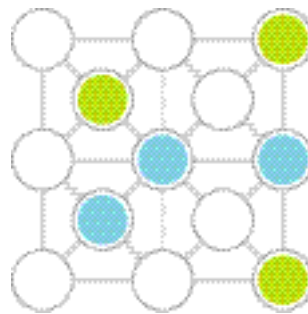
Then player 2 places a frog on the board where it can jump or be jumped by the first frog.



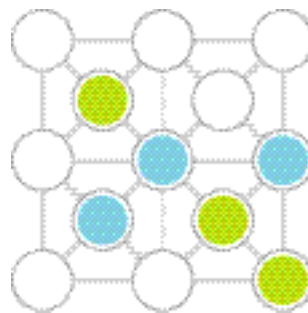
Players continue taking turns placing frogs on the board. The puzzle must always be solvable — it must be possible to jump frogs until only one is left. Can you see how the puzzle at left is solvable?



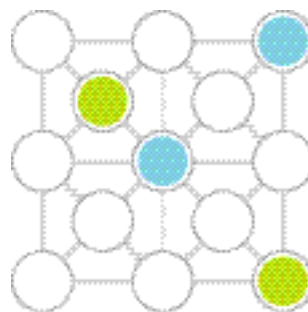
After a player has moved, the other player can challenge it by saying “Solve It!” The player who just moved must then solve the puzzle in one minute (or other time limit). Solving the puzzle wins the game; not solving the puzzle loses.



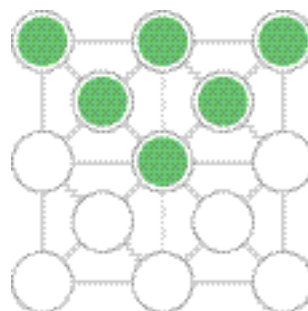
If there are no challenges, the final player to place a frog must solve the puzzle. Again, solving the puzzle wins the game; not solving the puzzle loses. In this position blue played last and can win the game by solving the puzzle.



Here is a trickier alternative to the last few moves. Can you visualize a solution? Can you visualize a solution that leaves the last frog in the middle?



Here is a position that should be challenged. Can you explain why this puzzle cannot be solved? Answer: the first two moves are forced, leaving the upper right frog stranded.



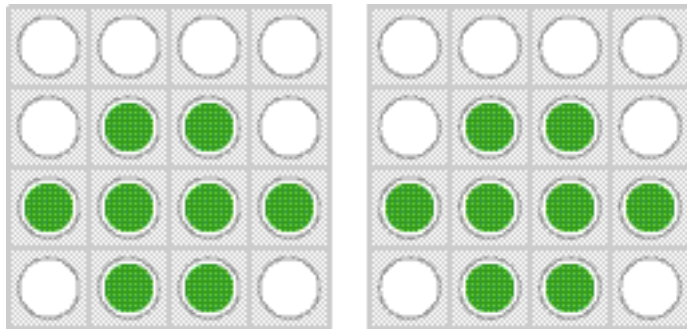
Here is challenge card xx from Hoppers. Can you visualize the complete solution? Hint: clear space for the two frogs in the upper corners to jump out.

SCRAMBLE

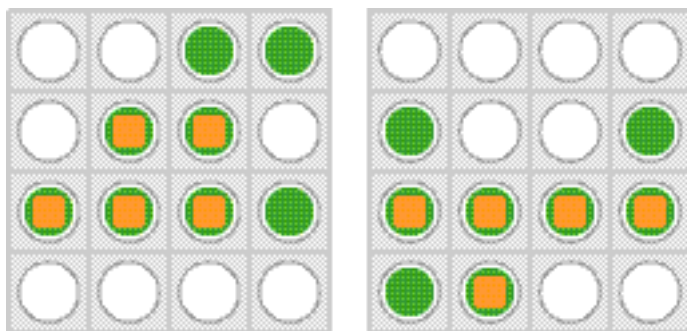
Game for 2 students on 2 Flipit boards

This game involves students in creating their own Flipit challenges. This game works poorly with Hoppers because moves are not reversible.

1. Setup. Two players each have identical Flipit boards and pieces. Start with one of the boards, empty. The two players take turns placing turtles on the board right side up (green shell) until it is fairly full, say 6 to 12 turtles. Copy the position onto the other board, so both boards have the same ending position. For instance, the boards might look like:



2. Scramble. From these identical positions, both players jump turtles around on their boards, using ordinary Flipit rules, trying to make a puzzle that is as hard as possible to solve. After one minute (or other time limit) players freeze their positions. Each frozen position should include at least one upside down (orange shell) turtle, and may include both upside down (orange) and right side up (green) turtles. For instance, the two scrambled boards might look like this (both positions were reached in five moves):



3. Race. Players exchange boards. Both players, starting at the same time, try to solve the puzzle they were given, turning all turtles right side up (green shell). The first player to solve their puzzle wins.

Note that both puzzles are guaranteed to be solvable, since they were constructed by scrambling a legal ending position. Working backwards this way works in Flipit because moves are reversible.

At the end of the game ask students to describe to the other student what they were thinking when they scrambled the pieces as they did. This way students verbalize their thinking, and learn from other students.

CREATE YOUR OWN

An open-ended creative activity

Problem posing is an important part of problem solving, since in real life there is no teacher to tell you which problems to solve. In the activities *Plan Ahead* and *Scramble* students construct their own puzzles. In this activity we explore puzzle creation in more depth.

Create your own . Invent your own Hoppers puzzle. Draw the opening position on a sheet of paper (see black-line masters on following pages). Label the locations with letters A–M and write down a solution.

Describe how you constructed the puzzle, and the criteria you used to judge whether the puzzle was good.

Here are three ways to get create a Hoppers puzzle:

- Work backwards. Start with a single frog on the board, and play the game backwards. A move in this backwards game consists of adding a new frog next to an existing old frog, then jumping the old frog over the new frog.
- Make a nice-looking pattern then see if you can solve it. Be sure you remember your solution, so you can write it down.
- Start with a Hoppers puzzle you like and change it by adding, removing, or moving a frog.

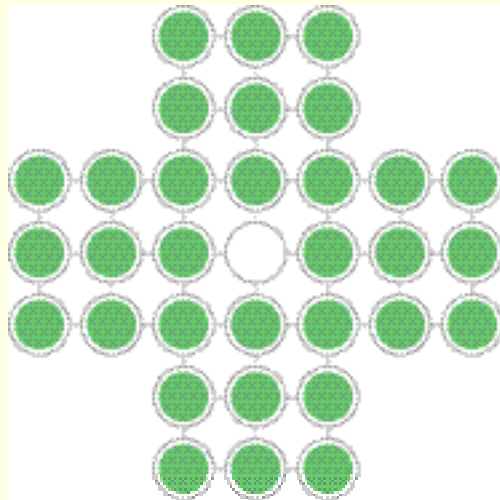
Give your puzzles to at least one other student and watch them try to solve it. Was it easier or harder than you expected? Where did the other student get stuck? Did the other student find a better solution than yours? Based on testing results, find a way to improve or change the puzzle.

Create sequences . Instead of creating just one puzzle, create a sequence of three puzzles: easy, medium and hard. If possible find a way to link the puzzles thematically. For instance they might use similar pieces, or hinge on the same strategy. Test your puzzle on at least one other student and see if they agree whether your assessment of which puzzle is easy, medium and hard.

Change the appearance . What could you use instead of frogs in Hoppers? What could you use instead of turtles in Flipit? Consider other animals, things besides animals, smaller settings and bigger settings.

Peg Solitaire

Hoppers is an example of a peg solitaire game. The most popular peg solitaire is this puzzle:



As in Hoppers, one peg jumps over another, and the peg that is jumped over is removed. Pegs can jump over only one other peg along horizontal or vertical lines. The goal is to leave a single peg in the middle.

Change the board . Try playing Hoppers on a different board. Draw boards that are larger, smaller, have different patterns of lines, or are based on triangles instead of squares.

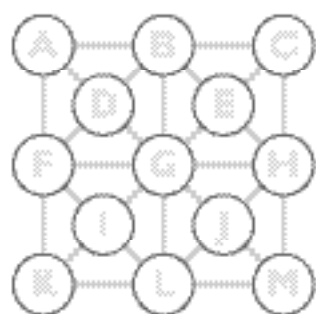
Try playing Flipit on a different board. Try a 5 by 5 or larger board. Try a triangular grid instead of a square grid.

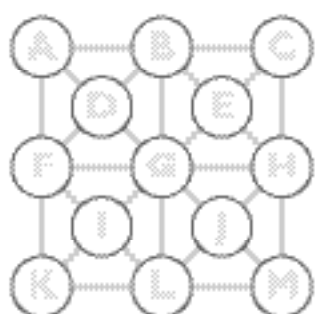
Change the rules . Invent a new game based on Hoppers or Flipit. Consider changing the goal of the game, the way pieces move, and what happens when a piece is hopped over. Can you make up a two-player game that uses the Flipit pieces and moves, but a larger board? Try borrowing ideas from Othello or Rubik's Eclipse, which also feature pieces that flip over.

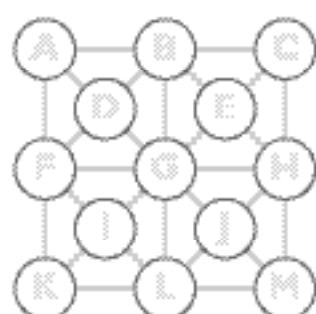
Programming . Suppose you wrote a program to solve Hoppers puzzles. Can you describe how it would work? How could you be sure you had found the shortest solution? How would you write a program to construct Hoppers puzzles?!

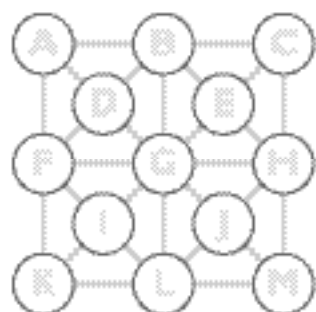
Hoppers Challenges

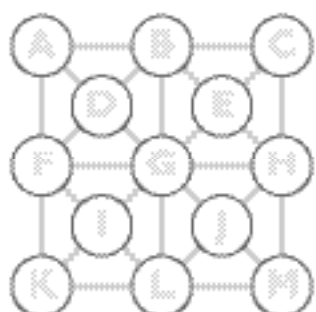
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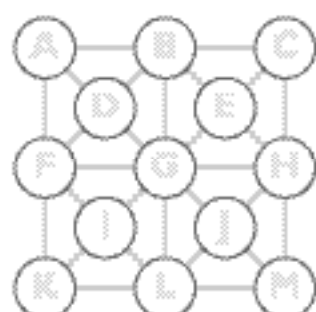


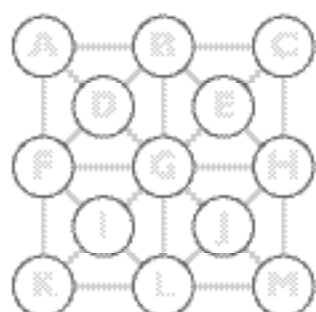


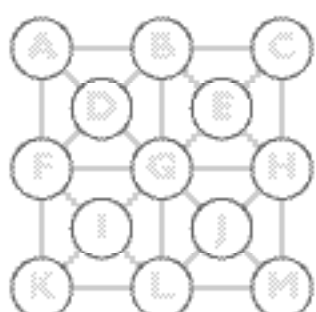


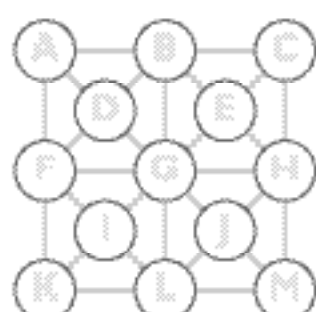






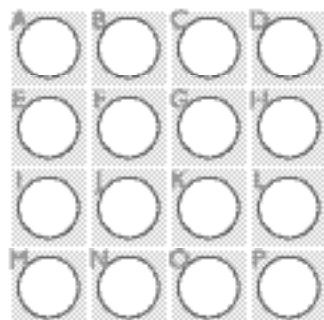


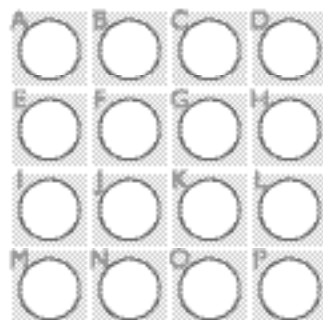


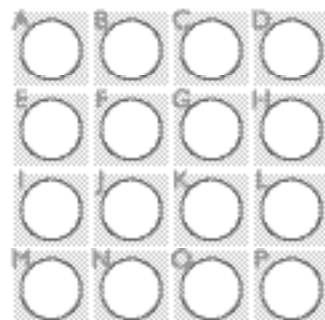


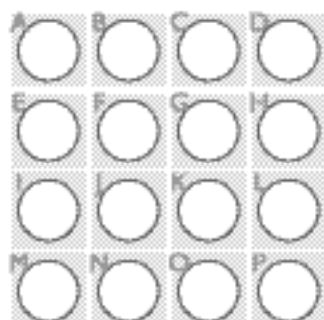
Flipit Challenges

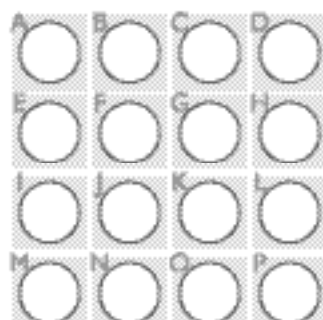
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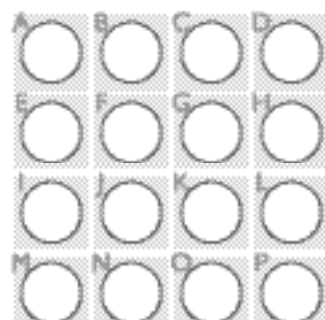


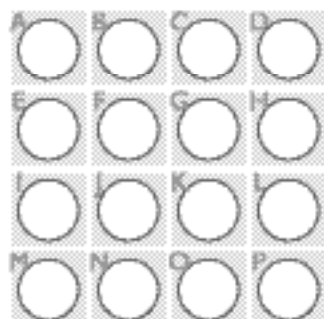


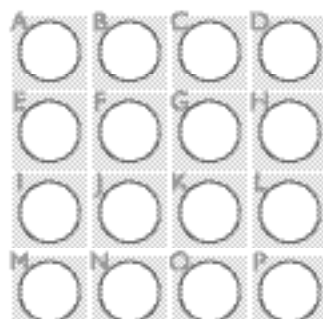


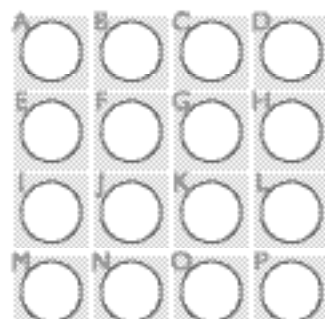












LEARNING FROM HOPPERS AND FLIPIT

Big open-ended discussion questions

Strategic thinking . Play other sequential thinking puzzles and games, and compare the strategies you use to the ones in Rush Hour.

- Lunar Lockout, Compare Rush Hour and Lunar Lockout. What is different and what is the same? Why are Lunar Lockout puzzles so much shorter than Rush Hour puzzles of the same difficulty? How well do Rush Hour strategies apply to Lunar Lockout? Can you invent a new game that blends rules from both games?
- Other puzzles. Compare Rush Hour with other sliding piece puzzles (such as the 15 puzzle), and other sequential thinking puzzles (such as Hoppers or FlipIt). What is different and what is the same? How well do Rush Hour strategies apply to these other puzzles? Some of these games have reversible moves, some do not. How does that make a difference?
- Game strategy. Try applying Rush Hour strategies apply to games of strategy such as chess or checkers. How is playing chess similar to or different from solving a Rush Hour puzzle?

Apply strategies to other situations . Applying what you have learned to other situations is one of the best ways to make it your own.

- Mathematics. Discuss ways that solving puzzles like Rush Hour is similar to solving problems in mathematics, such as algebra or word problems.
- Writing. Mysteries, with their complicated tangled plots, are much like puzzles. Read a mystery novel and diagram who knows what at each point in the story. How do you think mystery writers plot their plots?
- Planning a trip. When you plan a trip, you often have to work backwards in order to make sure you can get everything done before you leave. How else do Rush Hour strategies apply to everyday planning?

Classifying puzzles . These questions further develop a critical understanding of problem solving skills.

- Compare puzzles. Which puzzles are best for developing which types of problem solving skills?
- Classify puzzles using Venn diagrams. List 20 types of puzzles. Decide on 3 or 4 attributes for classifying puzzles. Sort the puzzles into categories using a Venn diagram. Find existing types of puzzles or invent new types of puzzles for categories with no members.