

## Teacher Guide for Games of Skill

### Special notes and timing

The lessons cover 4 different games, with two lessons per game. Each pair of lessons about one game could be a 30-minute block for students, or you can split them up by lessons and have 15-minute blocks on each lesson.

### Learning Objectives

Students will:

- Describe winning and losing positions in various games of skill
- Recognize winning strategies in skill-based games
- Create their own skill-based game

### Materials

- Math journal or notebook
- Colored pencils or pens

### Helping Questions

How might you begin?

What pattern do you see?

What happened when you played that game?

Can you figure out why you won/lost? What would you change about what you did?

What do you notice? What else do you notice?

Have you asked one of your classmates if he or she could see a pattern?

Why do you think that happens? (*Students may not know the answer to this question, but it helps them to think about it and try to explain it.*)

Can you explain it in a different way?

For Lesson 9: What rules can you change in one of the earlier games? What if the Triplets game was now 2-in-a-row or 4-in-a-row? What if the Keep Away game you could have 2 marks next to each other but not a 3rd? **Try to avoid giving hints this specific if you can—try to have the students come up with something on their own instead!**

### Assessment Options

- Look at the students' math journals. Ensure that they write down enough details so that they could look back and understand their work without having the lesson cards available.
- Students should be able to describe their strategy clearly enough so that somebody else could use the same strategy.

### Mathematical Notes

In Keep Away, students want to jump from a small number of boxes, such as 5 or 6, to a rather large number of boxes, such as 20, without doing in-between steps. Try to discourage this—they'll see the strategy much better if they increase by one box at a time.

There's an applet that plays *Keep Away* at <http://www.math.ucla.edu/~tom/Games/dawson.html>, but you don't have control over the size of the game board at this applet. This is the only website that calls it Dawson's chess—most other references to Dawson's chess are played on a 3-row chessboard and

involve pawns. I can't find other references to it in the literature. The name of *Keep Away* was coined by the author of these lessons and is not found in the mathematical literature.

There is an applet for *Triplets* at <http://www.mazeworks.com/home.htm>. According to this site, the game of triplets was proposed by mathematician Stanislaw Ulam.

Some students may have trouble working the *Towers of Hanoi* puzzle on paper without moving disks. You can make the disks out of craft foam or have the students cut out circles to make the disks. Having some thickness in the disks will help the students figure out the puzzle, since they'll be able to see if they have disks under the ones they see on top. You could also do it with blocks of different sizes, and circles drawn on a piece of paper to represent the pegs. There are many applets on the web that do this puzzle--my favorite applet is [http://nlvm.usu.edu/en/nav/frames\\_asid\\_118\\_g\\_3\\_t\\_2.html](http://nlvm.usu.edu/en/nav/frames_asid_118_g_3_t_2.html) or go to <http://nlvm.usu.edu/> and search "hanoi" to find it. The smallest number of moves to solve the puzzle for  $n$  disks is  $2^n - 1$ . Thus, for 3 disks, the students should be able to solve the puzzle using  $2^3 - 1 = 7$  moves, and for 4 disks, they should be able to solve the puzzle using  $2^4 - 1 = 15$  moves. Not every student will find the best solution, but you should be able to encourage them toward a good solution.

### Extensions

Lesson 9 shows one extension idea of having the student create his or her own game.

Students could research the best solution to the Towers of Hanoi puzzle, and then follow up by trying to find a general formula for the number of moves to get to the best solution.

### Teacher Reflection

- How did using games to teach logic affect classroom management?
- Did some students get frustrated with not seeing a winning strategy quickly? What can you do to ease that frustration?
- Did students adequately communicate their ideas? How can you help improve their communication skills?
- Did some students work better individually or in pairs/small groups? What support can you provide to the students to work outside their comfort zone?
- What were the greatest challenges for the students?

### Standards Addressed

#### Common Core State Standards (and Colorado Academic Standards in Mathematics)

1. Number Sense, Properties, and Operations
2. Patterns, Functions, and Algebraic Structures
4. Shape, Dimension, and Geometric Relationship

#### NCTM (National Council of Teachers of Mathematics) Content Standards

Number and Operations  
Algebra  
Geometry

## NCTM Process Standards

Problem Solving  
Reasoning and Proof  
Communication  
Connections  
Representation

### **References Used**

Dawson's Chess, <http://www.math.ucla.edu/~tom/Games/dawson.html>, accessed March 19, 2012.

MazeWorks, <http://www.mazeworks.com/home.htm>, accessed March 19, 2012.

National Library of Virtual Manipulatives, <http://nlvm.usu.edu/>, accessed March 19, 2012.

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