student who removes all his chips wins.

After we played one game we discussed the students' strategies for placing the 14 chips and then played again. After the second game we calculated the probability of the eleven possible sums and played again. The learning curve was dramatic from game to game!

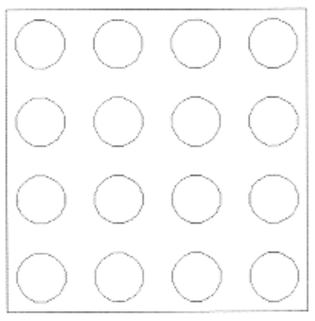
Students' Games

Throughout the unit students were assigned the task of creating a game, involving strategy, that they would play against one another. Many of the students came up with take-offs on games we had done in class. For example, one student invented "Make 35," which was obviously based on "Make 21." (In "Make 21," two students start with "0", and take turns adding "1" or "2" to the total; the student who "makes 21" wins.) But the students then added ideas, like using coins or dry pasta as markers, and then using the game to help teach younger students how to add.

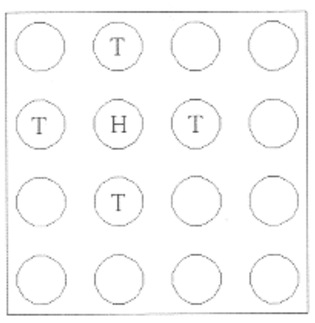
The following is a description of three of the games my students came up with:

Coin Trap

Directions: Player one (Heads) places a coin somewhere on the board. Player two (Tails) places a coin somewhere else on the board. Players then alternate placing coins on the board. The goal of the game is to try to trap the other player's coin inside four of your coins, as shown in the figure. (Coins along the edges cannot be trapped.) Once a player traps a coin he may flip that coin to his side. When all 16 coins have been placed, the player with the most sides up, wins.

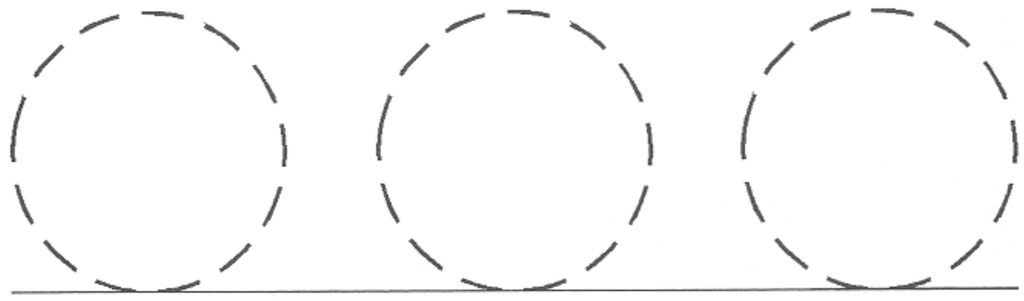


Coin Trap board

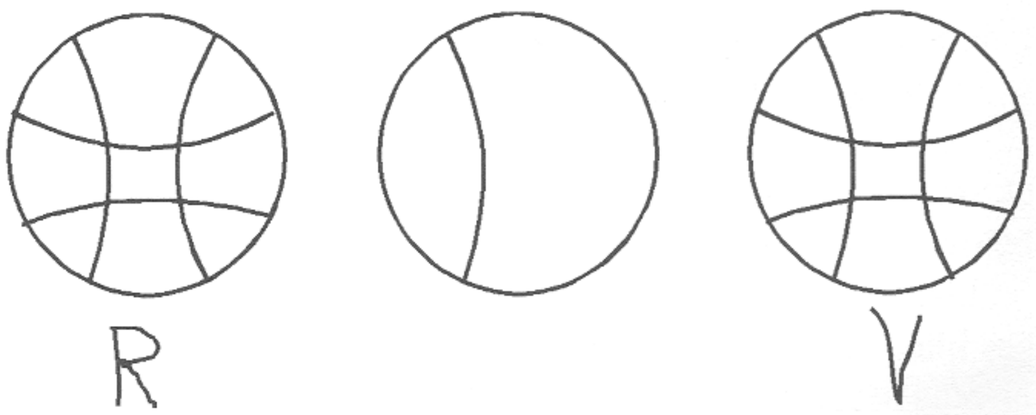


"H" is *trapped*

This student had clear directions, gave examples, and even mentioned a strategy for winning which, although it didn't always work, demonstrated that the student had understood the concept of "strategy." Unfortunately, it is easy to avoid getting trapped, and the games tend to end in ties. Few coins were stolen in the games I watched. [*Ed. note: If you make the game board larger, say 6 by 6, and only require 3 of the 4 adjacent spots to be occupied by the opponent for a "trap," then the game becomes more complex to analyze, and thus more interesting to play.*]



The Volleyball Game Board



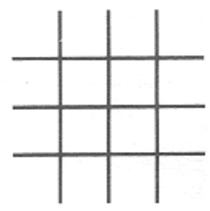
A Volleyball Game in Progress

Volleyball

Directions: Start with three dotted circles. Two players with different colored pencils play each other, alternately adding either one or two curves to one of the circles. A completed volleyball consists of 5 curves — the four curves on the inside and the circle itself, as shown in the figure. When a player completes a volleyball that player "wins" that volleyball, and gets to put his initial underneath it. The winner is the player who initials two volleyballs.

This game is a little like tic-tac-toe in its simplicity, but it was a thinker! [*Ed. note: One of the players has a winning strategy. Can you find it? Disguised hint: It is Player (10-5+3-8+2-7+6) who has the winning strategy.*]

Tic-tac-toe plus



Directions: This game is like tic-tac-toe, but a bit more challenging. Start with a 4x4 board (shown to the right). Players take turns putting their symbol (X or O) on the board. If a player makes 3 in a row, he draws a line through them. At the end of the game, whoever has more lines drawn is the winner.

Althought students can play this game for a while before noticing it, it turns out that Player I has an advantage in this game, and he will tend to win when beginners are playing. However, there is a strategy which Player II can use to always force a tie. Can you find it?

[*Ed. note: On larger boards (say, of size nxn) Player II still has a strategy to tie if n is even. But if n is odd, it may be that Player I is able to force a win. This seems like a difficult problem, and we welcome solutions.*]

My 3rd and 4th graders had finally identified the portion of the US map near Nevada which required 4 colors, but weren't sure if 4 colors were *really* needed. One group, containing the most precocious student, said, "I think it is possible to do it in three colors, but not by us. Probably by the smartest person in the world!" (Later, I made him become the smartest person in the world by disproving it himself!) –

Callie Hershey, LP '99