**Instructional Days**: 7-9

**Topic Description**:

This lesson reinforces the four main phases in the problem-solving process.

**Objectives**: The students will be able to:

* Solve a problem by applying the problem-solving process.
* Express a solution using standard design tools.
* Determine if a given solution successfully solves a stated problem.

**Student Activities**:

* Work individually to learn the history and rules of the Towers of Hanoi puzzle.
* Discuss how long this puzzle might take to complete for different sizes
* Work with elbow partner to complete the activity.
* Discuss solutions.

**Teaching/Learning Strategies**:

* History of Towers of Hanoi
  + Students read the history and rules
  + Play the game using 3 discs
* Discussion of Towers of Hanoi
  + How long did it take to solve the problem for 3 discs? How long do you expect it take for 6 or 12 discs?
    - Lead them to the idea that the solution time might grow differently from the size of the problem (e.g. 6 discs might be more than twice as long as the solution for 3 discs.)
* Students partner up and complete worksheet using tower of Hanoi puzzles.
* Go over the questions on the worksheet
  + Question 2: ask the students if there was a specific strategy that always completed the puzzle in the minimum number of moves. The minimum number of moves is 2^n-1
  + Question 5: (They might need a heavy duty calculator for this!) Approximately 585,000,000,000 years! (five hundred and eighty-five billion years)
* Task them to try and come up with an algorithm that always solves the problem in the minimum number of steps possible.
  + Along the way, help guide them by explaining how the problem is recursive.
  + The problem ultimately consists of moving the bottom layer of one stack to the top of another stack over and over again.
  + Whether there is an even or an odd number of discs is important.
* Optimal algorithm (from Wikipedia)
* A simple solution for the toy puzzle: Alternate moves between the smallest piece and a non-smallest piece. When moving the smallest piece, always move it to the next position in the same direction (to the right if the starting number of pieces is even, to the left if the starting number of pieces is odd). If there is no tower position in the chosen direction, move the piece to the opposite end, but then continue to move in the correct direction. For example, if you started with three pieces, you would move the smallest piece to the opposite end, then continue in the left direction after that. When the turn is to move the non-smallest piece, there is only one legal move. Doing this will complete the puzzle using the fewest number of moves to do so.

**Resources**:

* PBS Teachers Tower of Hanoi <http://www.pbs.org/teachers/mathline/concepts/historyandmathematics/activity3.shtm>
* Wikipedia Tower of Hanoi <http://en.wikipedia.org/wiki/Tower_of_Hanoi#Iterative_solution>