What is a Heuristic?

What are heuristics? How they can be used in problem solving?

A heuristic is a set of guidelines used to solve a problem. We can think of it as “a rule of thumb”—something that approximates rather than specifies.

An algorithm is a highly structured, step-by-step sequence that leads to a correct solution when correctly applied. Algorithms are applied when a solution process is clear.

We will be looking at a heuristic, which is used when a solution process is not clear.

Let’s look at an example of how we can use a heuristic to help create a square from tangram pieces.

The goal is to use all the tangram pieces to create a square that is congruent to the silhouette shown here.

A heuristic for the tangram puzzle may look like this:

- The side length of the created square cannot be longer than the given square silhouette.
- Every piece touches at least one of another piece’s edges and one of its vertices.
- Consider placing larger pieces before smaller pieces.
- Consider how two pieces might fill a corner.

This heuristic provides guidelines for deciding how to arrange the tangrams to form a square.

Let’s use the heuristic to create a square from tangram pieces.

The side length of the created square cannot be longer than the given square.

I am wondering how the side lengths of each piece compare to the side length of the square.

I noticed that one side of the large triangle is the same length as my square. I begin by placing the large triangle so that it aligns with the side at the top of the square.

Knowing that two pieces touch alongside at least one edge and share at least one vertex, and that I should place larger pieces before smaller pieces,
I will place the second large triangle so that one side and one vertex aligns to the first large triangle.

My remaining pieces must compose the other half of the square.

Another part of the heuristic is to consider how two pieces might fill a corner.

The larger remaining triangle fits in the corner, as does the smaller triangle. Thinking of the heuristic, I placed the larger triangle in the corner.

Let me see if one of the larger remaining pieces—the parallelogram or the square—fits here.

The square has a ninety-degree angle, but it leaves an uncovered area that cannot be covered by the remaining pieces.

The parallelogram can be placed so that it touches an edge and shares a vertex. However, it leaves an uncovered area that cannot be covered by a remaining piece.

I am now having to consider that the larger triangle may not be the shape that fits in this corner.

Let me try one of the smaller triangles.

One of the larger remaining pieces is the parallelogram. Where can I place the parallelogram?

After considering the remaining shapes needed to fit in the square, I decided to place the parallelogram in the lower corner of the square as suggested by the heuristic, “Consider how pieces might fill a corner.”

Next, I want to determine if one piece can be used to fill the remaining corner.

Looking at my remaining pieces, I think I will try the larger triangle. It has a ninety-degree angle.

At this point, I can place the remaining pieces in the space provided.

All pieces share at least one edge and vertex with another piece. The square silhouette is covered without any overlapping pieces.

This heuristic helped to build a square from tangram pieces. It can also be applied when using tangram pieces to create other geometric figures, such as parallelograms.
Keep in mind that a heuristic does not guarantee a correct solution. It is a guideline that will help in determining a correct solution.

Because heuristics provide guidelines, or “road maps,” they are great tools for problem solving.

The problem-solving model in the mathematics Texas Essential Knowledge and Skills, or TEKS, is a heuristic. It is a helpful heuristic when a solution path for a problem is not obvious or clear. Each step in the heuristic guides one along a problem-solving path. Because it does not tell exact steps to follow to determine a solution, this heuristic can be applied to problems across strands and problems of varying levels of complexity.

Let’s compare our tangram heuristic for a square to the problem-solving model in the mathematics TEKS.

One of the components of a problem-solving model is analyzing given information. In the square task, tangram pieces were analyzed based on attributes, including side length and area.

A plan to create a square using seven tangram pieces included considering the largest pieces first, trying to complete corners, and comparing the length of the tangram pieces to the side of the square silhouette.

When carrying out the plan to create a square, it became necessary to revise the original plan when the shapes placed below the triangle would not fit properly in the square silhouette.

Based on the trial and error of placing the square in the corner, it was necessary to go back and analyze the remaining pieces and the conditions necessary for making a square.

When using a problem-solving model as a heuristic to solve a problem, it may be necessary to analyze the problem and its attributes again in order to revise a plan or create a new plan.

Upon completing the square, the tangram heuristic for a square was evaluated to determine if the task was successfully completed.

In a problem-solving model, it is important to justify the solution and evaluate the problem-solving process.

In both situations, it is important to evaluate the process so that it informs future attempts to solve similar tasks or problems.
As you share the problem-solving model with your students, be sure to remember the model is a “rule of thumb”—a rough guideline for tackling problems where no immediate solution or process is obvious.