

Lesson 3: Exploring Problem Solving

Overview

Question of the Day: How can we apply the problem solving process to many different kinds of problems?

In this lesson students apply the problem solving process to three different problems in order to better understand the value of each step. They will solve a word search, arrange seating for a birthday party, and redesign a classroom. The problems grow increasingly complex and poorly defined to highlight how the problem solving process is particularly helpful when tackling these types of problems. The lesson concludes with students reflecting on their experience with the problem solving process. They will justify the inclusion of each step and will brainstorm questions or strategies that can help them better define open-ended problems, as this is often the most critical step.

This lesson will likely take two class periods or more to complete. The first two problems may fit into a single class period but the third will need to be moved to a second day.

Alternate versions of this lesson are also available.

- **Animal Theme**
- **Games Theme**

Purpose

This lesson provides students with more practice with the problem solving process in a variety of contexts. It highlights the fact that the problem solving process is particularly helpful when approaching poorly defined problems. The final brainstorm of the lesson provides students with some strategies and questions they can ask to better define problems for themselves, since this is often the most critical step. The problems seen in this lesson also help to drive a discussion in the following lesson about the types of problems that computers are well-suited to solve.

Assessment Opportunities

1. **Apply the problem solving process to approach a variety of problems**

On page 5 of the Activity Guide, check the chart to make sure that students are putting in reasonable steps for each of the problems.

Objectives

Students will be able to:

- Apply the problem solving process to approach a variety of problems
- Assess how well-defined a problem is and use strategies to define the problem more precisely

Preparation

- Print the activity guide for each student
- Scratch paper for the Birthday Party problem
- Poster to record strategies for defining problems in wrap up discussion

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the teachers

- **CSD Unit 1 - Problem Solving and Computing** - Slides

For the students

- **Solving Problems** - Activity Guide

2. Assess how well-defined a problem is and use strategies to define the problem more precisely

For the last question on page 5 of the Activity Guide, make sure that students have at least one question or strategy that would be an effective way to better define a problem.

Standards

Full Course Alignment

CSTA K-12 Computer Science Standards (2017)

- **AP** - Algorithms & Programming

Agenda

Lesson Modifications

Warm Up (5 minutes)

Activity (80 minutes)

Understanding the Problem Solving Process

Wrap Up (5 minutes)

Teaching Guide

Lesson Modifications



Attention, teachers! If you are teaching virtually or in a socially-distanced

classroom, please **click here** to access modifications that can be used during this lesson.

Warm Up (5 minutes)

Journal Prompt: Think of the silliest problem the problem solving process could help with. Be prepared to say how each step of the process could apply.

Allow students to share out individually.

Discussion Goal

This discussion serves as a review of the problem solving process and highlights how many different types of problems there could be. Encourage students to be creative and have some fun with the different "problems" they might solve.

Remarks

With such a wide variety of problems and strategies, it's important to be able to think about how best to use the problem solving process. Today we're going to look at some different types of problems, talk about what makes them different, and reflect on how the problem solving process helped us solve them.

Question of the Day: How can we apply the problem solving process to many different kinds of problems?

Activity (80 minutes)

Group: For all three activities students should be working together in groups, even if they record their results individually. Groups of 2-4 will likely work best.

Distribute: Hand out the activity guide, one copy for each student. For now they can be face down so that the word search isn't visible.

Solving Problems

Word Search

Once students are in pairs ask them to flip over their activity guides and begin the first challenge. They'll be finding the 8 words in a 20 by 20 grid of letters.

Circulate: Walk around the room observing how students are addressing the problem. Make sure that groups are not sharing locations of words. Encourage them to think about how making a plan might help them address this task.

💡 Teaching Tip

Integrating the Problem Solving Process: This word search can actually take several minutes, especially if students are approaching without some kind of strategy. Remind them that one step is to Prepare before they just jump in and start hunting.

Answer Key: An answer key is provided for verified teachers as part of the resources in this lesson plan. If you do not see the answer key listed as a resource, **follow these steps** to become a verified teacher.

Once all groups have finished, bring the class back together. Have students flip to the last page of the activity guide where there is a table to record their experiences with the problem. They will record what parts of solving this problem fall within each step of the problem solving process.

Discuss: Briefly discuss with students what parts of the activity they felt fell into each step of the problem solving process. Some possible points to make after students share are below.

- **Define:** This problem was already very well defined. Not all problems will be, though.
- **Prepare:** Developing a plan with a team (such as divvying up the words, splitting the grid into separate sections that each member searches in, or just being methodical about looking for words) makes this problem much easier to solve than random searching.
- **Try:** Patience and persistence is important to see your plan through
- **Reflect:** If your early plans are not working you can regroup and choose a new plan

Birthday Guests

Move the class on to the birthday guests problem. Groups may still work together on their solutions but shouldn't share with other groups.

Circulate: As before, circulate around the room noting the types of strategies that groups are using. Remind them to use the steps of the problem solving process to help them if they're getting stuck.

💡 Teaching Tip

Integrating the Problem Solving Process: This problem is particularly challenging if you don't Define the problem well. If you take it at face value, your job is to randomly guess and check where to put individual people until you find a solution. It is much easier if you define the problem as place groups of friends instead. Make groups of 2 or 3 you know need to be together and then figure out which groups can't be at the same table.

This isn't the only approach to the problem, and you shouldn't rush to introduce it as such. Rather, encourage students to discuss with one another what they know needs to be true at the end and whether different approaches might help.

Draw Pictures: Students will likely do better if they draw pictures. You may wish for students to use a journal or scratch paper as a place to brainstorm ideas.

Extending the Problem: If one group finishes far before others you could give them a blank sheet of paper and ask them to solve the problem again but with a new condition of your choosing (e.g. pick two people sitting at the same table in their solution and ask whether they can solve the problem now that those two people are also in a fight.)

Once groups have finished solving the problem ask them to move to the last page of the activity guide to record how they used the problem solving process to solve this problem.

Discuss: Briefly discuss with students what parts of the activity they felt fell into each step of the problem solving process. Some possible points to make after students share are below.

- **Define:** The problem seems to be a problem of seating individuals. If you instead think of it as a problem of seating groups of people who would like to be together there are many fewer possible solutions to consider.
- **Prepare:** Ask students to share what types of strategies they considered before just starting to assign people to seats.
- **Try:** As before, patience and persistence is important to see your plan through
- **Reflect:** If early strategies are not working groups may have regrouped and tried a more structured approach

Redesign Your Classroom

Move the class on to the Redesign Your Classroom problem. Each member of the group will individually be developing a plan for a layout that follows criteria they'll develop as a team. Give students time to choose the goals they'll use to plan their layout. For example there may be certain things they'd like to move, new items want to include, people they want help them, etc.

Circulate: Once groups have goals, they will move through the activity by developing a plan to redesign the classroom. Give them a time limit on this part of this process, e.g. 15 minutes, to make sure they focus on the key elements on their plan rather than perfecting it. They should record key information about their plan in their activity guides.

Teaching Tip

Integrating the Problem Solving Process: This problem is intentionally very open-ended and in fact has students develop the criteria they'll use to measure success. This problem does the best job of highlighting all 4 steps of the process and walks students more intentionally through the Define, Prepare, Try, and Reflect stages.

Give Resource Ideas: Students may just brainstorm ideas and layouts by themselves, but also let them know about other resources such as search engines and image searchers to help give them inspiration if they are stuck. Let them look at other classrooms online for help.

When to Stop: This problem could easily take a 50 minute class period. Let students know ahead of time that there are time limits on what they're doing and encourage them to think how they would improve their route using the problem solving process if they had more time to iterate.

Bring groups back together and have them share their initial plans. On the activity guides they can record the feedback their classmates give them on their plans.

Once groups have discussed what they like or don't like about their classmates' proposed plans, they can re-examine them and make improvements. Are there other things they'd like to do? Do they have new goals? Give them several minutes to make improvements to their plans before deciding on a final version.

Bring the class back together and have them record the different steps of the problem solving process that they used in their activity guides.

Discuss: Briefly discuss with students what parts of the activity they felt fell into each step of the problem solving process. Some possible points to make after students share are below.

- **Define:** This problem was not well-defined. They needed to decide for themselves what a "good" room looked like, and this definition could have even shifted throughout the process.
- **Prepare:** Narrowing down a list of possible layout is helpful. You may also choose to make the point that this entire activity is an example of preparation. Some layouts just don't make sense or others work better, so you need to do the kind of planning they're doing here.
- **Try:** As before, patience and persistence is important to see your plan through
- **Reflect:** In this problem reflection came primarily through feedback from peers. Some layouts might not end up being that interesting to other group members. Some are fun but require too much moving or too many new things. Feedback is an important part of the reflect step, especially in group work.

Understanding the Problem Solving Process

Prompt: You just solved a number of very different problems. With your tables review the notes you took on each of the problems. Be ready to report out on the following questions

- For each step in the problem solving process, what is its purpose? Why is it included?
- Are there any kinds of problems that the problem solving process is particularly helpful at solving?

Discuss: After tables have discussed their responses for several minutes invite the whole class to share their rationale for including each step in the process. Once each step has been discussed, move on to the second question. This question may have many responses and you should allow students to share their thoughts and experiences. If it doesn't arise naturally as you leave the conversation offer some or all of the ideas mentioned in the discussion goals.

Discussion Goal

Goal: Students have practiced using the problem solving process on a number of different problems. Help them synthesize the notes they have been keeping to better understand the role of each step and the value of the problem solving process in general. A sample set of conclusions is below but you should allow students to share your own insights before offering your own.

Define: without defining a problem you might solve the wrong problem, not know where to start, or not know when you're finished

Prepare: Even well-defined problems usually have many possible approaches. Make each try more likely to succeed by first examining your options and anticipating challenges

Try: Without trying you'll never get anywhere. It's important to be persistent and patient so long as your plan still may work

Reflect: You'll likely not solve the problem the first time or there will be a better way to solve it. Learn from your past attempts and get ready to start the process again.

The Problem Solving Process: While you may notice you're using it even for small and trivial problems, this process is incredibly useful for large, complex, poorly-defined, or open-ended problems. It helps you make progress when the way forward may not always be clear.

Wrap Up (5 minutes)

Question of the Day: How can we apply the problem solving process to many different kinds of problems?

Journal Prompt: The problem solving process is particularly helpful when we encounter poorly-defined problems. We saw today that without a well-defined problem the rest of the problem solving process is difficult to follow. What are some questions or strategies we can use to help us better understand and define problems before we try to solve them?

Discuss: Have groups share quickly before taking suggestions from the class as a whole.

Discussion Goal

There are many different strategies to help define problems, including the questions on the previous lesson's activity guide. Some potentially useful questions include:

- Who in particular the problem affects. What specifically do they need? In what kind of situations?
- Why the problem exists? (And why does that problem exist?) Keep asking to get to the heart of the problem.
- How could I be able to tell the problem had been solved? What could I observe or measure?

Remarks

Excellent work everyone. We now understand a great deal about the problem solving process. This is going to be an incredibly useful tool that we'll use repeatedly throughout the year as we dig deeper into understanding the world of computer science.