CALCULUS OPTIMIZATION

"Make It Fit"

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SUMMARY

In this lesson, students will explore the calculus concepts of optimization and learn to increase their ability to identify, model, and set up functions to solve calculus word problems, focusing on the conceptual understanding over calculations. This is done through a mix of activities and by playing through Mission Prime, a digital game-based learning (DGBL) module. The DGBL module gives students the opportunity to explore and apply the concepts within an interactive world that provides them with three-dimensional visualizations of the word problems they are attempting to solve.

ESSENTIAL QUESTION

Why do we need optimization? What is it used for?

DURATION	TIME FRAME	SUBJECT(S)	GRADE LEVEL(S)
180 Minutes	3 - 4 Class Period(s)	Mathematics	11th, 12th

LESSON SNAPSHOT

1. ENGAGE:

Use the Two-Minute Paper strategy to get students thinking about optimization and to refresh what they learned in the previous lesson.

2. EXPLORE:

Students will play the first two missions of Mission Prime to explore the concepts of calculus optimization.

3. EXPLAIN:

Use the Example and Non-Examples strategy to help students explain how they would use optimization in their daily lives.

4. EXTEND:

Students will extend their understanding of the concepts by playing the third mission of the Mission Prime DGBL module.

5. EVALUATE:

Using the "Box Optimization Worksheet," students will apply the concepts they've learned to a physical optimization problem to show their understanding of the concepts.

LESSON PROCEDURES

1. ENGAGE

TEACHER'S NOTE: PREQUISTIES

It is important that students have certain perquisite knowledge before attempting this lesson. This includes a solid understanding of algebra related to expressions and functions, geometry knowledge related to the shape and volume of simple and 3D shapes, and differential and integral calculus.

At the start of class, hold up a can of soup and ask your students what they know about optimization and how that relates to the can you are holding.

Have each student take out a piece of paper and, using the Two-Minute Paper strategy, have them write everything they know or think they know related to the concept and how it might apply. Once your students have finished writing, have some students share out what they've written.

2. EXPLORE

Once your students have finished sharing from their papers, introduce them to the Mission Prime DGBL module. Click here to learn more about the game. Play through the game at least once before teaching with the it so you have a general understanding of the story and the characters your students will encounter as they play.

TEACHER'S NOTE: ACCESSING THE GAME

You will need to have game access set up ahead of time. If you are using the iPad app, you only need to install the app to be ready to go. If, however, you need students to play the game via computer, contact either Will Thompson (will.thompson@ou.edu) or Javier Elizondo (elizondoj@ou.edu) directly at the K20 Center to be granted access. Further contact information can be found at the end of the teacher's guide in the Attachments section.

Prepare students to play the game on their computers or tablets and have them play through the first two missions, which should take roughly 30-45 minutes. You do not need to give them further instruction here. The game will introduce them to its mechanics, concepts, and story. At this point, take time to walk around the room, helping students who are confused or stuck and observing their progress. A handout with the proper order of operations for each mission is in the Attachments section should you need it.

TEACHER'S NOTE: ALTERNATIVE FOR TECHNOLOGY LIMITATIONS

If it is not possible to supply each student with access to the game, having students play the game in small groups will also work. You may even find this perferable then individual play. It is however recommended that these groups have no more than four students apiece.

TEACHER'S NOTE

Mission Prime consists of four missions and each one becomes progressively more challenging. Because of the length of the game, this lesson breaks game play up into two sections. The first section covers the first two missions, and the second section covers the third mission. Because of the time required to play it, the fourth mission is not required for this lesson. However, you may have your students play this if you wish.

3. EXPLAIN

Having played some of the game and seen how optimization is applied within its virtual world, use the Example and Non-Examples strategy to help students think about how they would use optimization in their daily lives.

Form your students into groups or continue using the groups they played the game in. Have them come up with four examples and four non-examples with explanations. Then, have each group share out one of each with the class and discuss them.

If your students' examples don't already show it, you might remind them that optimization does not only pertain to physical items. It can also be used to maximize the crop yield of a field or the return on investment of a business venture. Optimization means finding the maximum or minimum values of a quantity or finding when these maximums or minimums occur.

4. EXTEND

Now, have your students to go back and play mission three. This should take around another 30-45 minutes to complete. As mentioned previously, it is not required that players complete mission four, but if you have students who complete mission three very quickly, you can have them continue on to the final mission. The final mission will take another 30-45 minutes to complete.

TEACHER'S NOTE

Again, having students play the game in small groups will work if it is not possible to provide each student with individual access. It is recommended that these groups have no more than four students apiece.

5. EVALUATE

Now that your students have played the game and applied their optimization knowledge in a virtual world, it's time to have them translate that to the physical world. Have your students form groups of four to five. If they were in groups to play the game, you can continue using those same groups.

Give each group some graph paper and the "Box Optimization Worksheet" found in the Attachments section. Give students 15-20 minutes to discuss the problem, create their paper boxes, and complete the worksheets. Then, have groups share out the volumes they ended up with. Record these numbers on the board.

Find whose box had the highest volume and have them share the processes they used to determine the size of the squares they were going to cut out of the graph paper. Make sure to clear up any misconceptions students might have related to the concepts here as well.

STANDARDS

- Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.
- Build new mathematical knowledge through problem solving
- Solve problems that arise in mathematics and in other contexts
- Apply and adapt a variety of appropriate strategies to solve problems
- Monitor and reflect on the process of mathematical problem solving
- Recognize and apply mathematics in contexts outside of mathematics

MATERIALS LIST

- Computers with Internet access or an iPad for each student
- K20 Game Portal accounts or iPad apps of Mission Prime for each student
- Whiteboard
- Writing materials - pen, pencil, paper, etc.
- Graph Paper
- Scissors
- Scotch Tape
- Box Optimization Worksheet

ATTACHMENTS

- Mission Prime Instructors Guide 2017-08.pdf
- Box Optimization Worksheet.docx
- Mission Prime Mission Solutions.docx

RESOURCES

- K20 Center. (n.d.). Two-minute paper. Strategies. Retrieved from https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f506cf73
- K20 Center. (n.d.). Example and non-example. Strategies. Retrieved from https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f5073fd8
- K20 Center. (2017). Mission Prime, OK: The Board of Regents of the University of Oklahoma K20 Center. (n.d.).