K20CENTER
The University of Oklahoma

TEACHER GUIDE

The UNIVERSITY of OKLAHOMA

VIRTUAL LEARNING EXPERIENCES

ABOUT MISSION PRIME

GAME NARRATIVE

It is the not-too-distant future, and the people of earth have decided to undertake a great project: to send a few brave scouts across the cosmos to explore potentially habitable world light years away. The mission of these lonely space-travelers, when they awaken at their destinations, is to prepare a safe, habitable environment for the colonists that will be a few year behind them.

The player takes on the role of one such astronaut after arriving on the planet. With only a rudimentary AI assistant as company the player must work out mathematically the best way to use their limited resources to survive and build a colony in this alien environment.

PURPOSE

The purpose of Mission Prime is to support the teaching of undergraduate calculus to college freshmen and sophomores.

THE OBJECTIVE OF THIS INSTRUCTION IS THAT, GIVEN A CALCULUS WORD PROBLEM, THE STUDENT WILL BE ABLE TO:

- *Identify the type of problem*
- *Model the problem*
- *Select the appropriate tools to solve the problem*
- *Set up a function to solve the problem*
- *Find the correct answer to the problem*

The instruction focuses on the identifying, modeling, selecting tools, and setting up a function to solve a word problem. The performing of calculations will be de-emphasized in favor of a conceptual understanding of the problem.

In the game, the player will be given a word problem, and asked to find the answer in the context of the objects present in the world. The player will be able to select object, make necessary measurements, view how objects move or change through time, create viable parameters, and ultimately select the mathematical 'tools' necessary to solve the given problem.

The player can assemble a function to solve the problem. This is done by selecting from a set of given formulas or tools, arranging these, and applying variables found in the game environment. Once the function is built out of these various components the player will be able to perform various operations on it and finally select the correct answer to the problem from the outputs.

This will allow players to focus on learning the conceptual framework of the problem without having to fuss with the more tedious (and easier to learn) aspects of performing calculations and memorizing formulae.

Each scenario in the game will represent a new problem and will build on previous learning, allowing the player to incorporate new mathematical concepts as they progress.

HOW TO
USE THIS GAME

Mission Prime works as a supplement to classroom or online teaching methods.

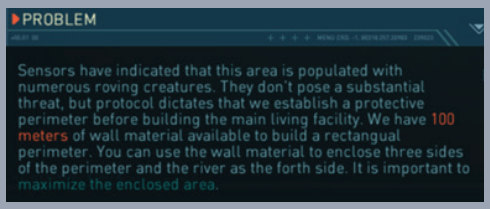
This game is not intended to teach calculus skill to students who have no backvground in calculus; instead, it is intended as an alternative practice activity that can be assigned instead of homework or other practice activities. While many students may struggle with the abstract nature of mathematics, this game offers a rich interactive environment and a unique way for students to visualize and interact with math problems.

PLAYING MISSION PRIME

Each scenario includes a single calculus problem that relates to the current scenario. When a player successfully completes a scenario, he or she will automatically progress to the next scenario.

TUTORIAL

The first time the student plays the game they will be taken through a quick tutorial that explains the interface and the purpose of the game. Each tutorial panel will explain a different portion of the interface. Students should be instructed to read the tutorials carefully to avoid later confusion. Most tutorials will require the student to take some action in the game in order to move on. For most players, this tutorial should be all that is required to learn the game.



PROBLEM TEXT

This section describes the word problem that the player is trying to solve. All of the information necessary to solve the problem is included here.

THE ENVIRONMENT

In the center of the screen you will see a three dimensional rendering of the problem. This 3D image will help the student to visualize what the problem means in real space. Any variables in the problem will also be variable (movable) in the environment.

For example, in Level 1, the student can click and drag the fence to adjust its dimensions. Being able to see and interact with these environmental objects will help the student to visualize how the word problem relates to the real word.

Known values and variables are displayed on the objects in the environment. All of these values and variables correspond directly to the values and variables in the problem and in the tool box.

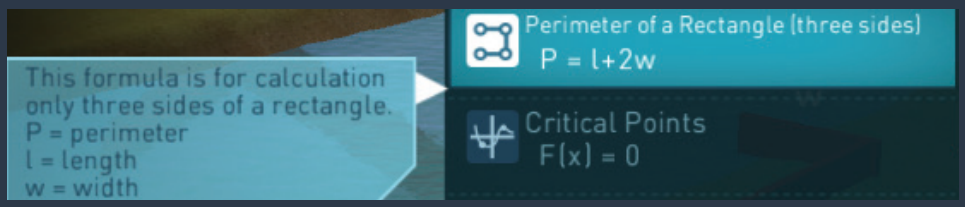
CAMERA CONTROLS

These controls allow the player to rotate the camera and switch between a 3D and 2D view of the environment. The 3D mode is meant to simulate a realistic view of the objects involved in the problem. The 2D view simulates the type of diagram the student might encounter in a traditional math course. Many students find that viewing objects from multiple angles can be helpful in understanding the problem.

TOOLS

The Tools Panel houses all of the formulas and operations available to the player. This panel will contain all the formulas necessary to solve the problem. It will also contain additional formulas that are not needed. By clicking on any formula, the player can see a helpful explanation of that formula and the variables it contains.

Players can drag items from the tool box into the workbench in order to manipulate them and work toward a solution for the problem. Items highlighted in blue are for use in the Function panel instead of the workbench.



WORKBENCH

The workbench area allows the student to work with mathematical tools and apply them to the problem at hand. The student can drag tools from the tool box onto the workbench.

The formula is now displayed with a solution for each variable below it.

The student can also drag known values from the environment onto any of the solutions displayed below the formula. This will replace the solution variable with the known value. All other instances of that variable in the workbench will automatically be replaced and all solutions will be updated. In this way, the student can see how the known values affect their formulas and can work toward customizing the formulas for the problem they are trying to solve.

SOLUTION

In this section, the player will assemble the function that they will use to solve the problem. The player can drag formulas form the workbench into the solution area. The player can also drag in the *First Derivative* and *Critical Points* operations from the Tools panel.

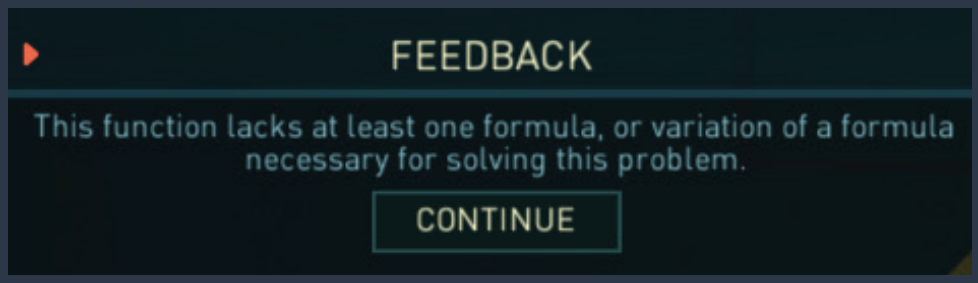
Each item added to the Solution panel will be applied in order. This means that the player can add a formula from the workbench to create a function, and then add another formula with will combine with the first and replace any common variables.

For example, if a player adds A=LW to the solution panel then adds L= -2W+100, the l in A=LW will be replaced with -2W+100. This will result in a function reading F(W)= -2W^2+100W.

FEEDBACK

Instructional feedback will be delivered to the player when the player selects a solution to any given problem.

The feedback is intended to help direct the player toward the correct solution without explicitly stating how to solve the problem.



Players will be expected to test different strategies, review feedback, and revise their strategies before finding the final solution. Players will not be penalized for selecting wrong solutions, but they will only be able to progress through the game by selecting correct solutions. This forms a low-states environment where the player can gain competence with a given set of skills before moving on to more difficult problems.

SOLVE BUTTON

The solve button, located on the right side of the solution panel, allows the student to complete the level once they feel that they have gotten the right answer. If the student doesn't have the right answer, they will receive feedback that gives hints on how to improve their function.

UNDO BUTTON

The undo button appears as a red X in the workbench and function areas, and allows the student to remove any formula from the workbench or solution areas.

OPTIMIZATION

The player has just arrived on the alien planet and is tasked with setting up the initial facilities to start the colony.

These include a living facility, power plant, and defensive wall. The player must use calculus to adjust the design of each structure to maximize utility given limited resources.

THE OBJECTIVE OF THIS INSTRUCTION IS:

- *Identify the constraints of a given system.*
- *Craft a function to calculate the absolute extrema of a system within those constraints.*
- *Use the first derivative test to determine the maximum or minimum values.*

SCENARIO 1

PROBLEM TEXT

Sensors have indicated that this area is populated with numerous roving creatures. They don't pose a substantial threat, but protocol dictates that we establish a protective perimeter before building the main living facility. We have 100 meters of wall material available to build a rectangular perimeter. You can use the wall material to enclose three sides of the perimeter and the river as the forth side. It is important to maximize the enclosed area.

SCENARIO 2

PROBLEM TEXT

The living facility is a rectangular building. We have a special protective alloy to use on the walls, foundation, and roof. We only have 1000 units of the material. Every square meter of roof space requires 6 units while the walls only require 1 unit per square meter. The foundation requires 10 units per square meter to be stable. The facility must be exactly 3 stories tall (9 meters). We need to maximize the floor space of the facility given our limited building materials.

SCENARIO 3

PROBLEM TEXT

In order to power the facilities, you will need to set up the hydraulic generator unit. The unit has a conical protective casing with a radius of 6 meters and a height of 10 meters. Before installing the casing, we need to build a generator unit that will fit inside of it. The generator unit is cylindrical, but its dimensions can vary, based on your specification. The larger the generator is, the more power it can produce, so try to maximize the volume while remaining within the dimensions of the protective cone.

SCENARIO 4

PROBLEM TEXT

Now that the living facility and generator are both built, we need to connect them. My measurements indicate that the distance between the two is 100 meters. The river is 50 meters wide. It will cost us 10kg of cabling material per meter in the water and 7kg of cabling material per meter on land. We need to find the most efficient rout for the cable to minimize the weight of the materials used.

FUTURE EXPANSIONS

This game has been designed to be easily expanded to include other chapters, teaching other topics in calculus. This manual will be updated as new content is added.

ABOUT THE PROJECT

The K20 Center for Educational and Community Renewal is a statewide education research and development center which promotes innovative learning through school-university-community collaboration. Our mission is to cultivate a collaborative network engaged in research and outreach that creates and sustains innovation and transformation through leadership development, shared learning, and authentic technology integration.

The K20 Center's Virtual Learning Experiences (VLE) development team is tasked with creating game-based learning experiences to be used in undergraduate courses at The University of Oklahoma. The experiences are designed and developed by a small team working with volunteer University professors.

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