LESSON PLANS

OVERVIEW

Alien Rescue is an open environment. While there are several tasks students must complete in order to develop a solution, and a logical order in which to complete these tasks, students may generate alternative paths to solution. The following lesson plans therefore include a fair amount of flexibility and are designed to provide support for you the first time you use *Alien Rescue* with your class. With experience you will quickly come to see alternative paths which emphasize different skills and information. You should modify these plans to best suit the needs of your class and demands of your curriculum.

The following plans presume that the typical class period is divided into two parts. The first is a group discussion, in which all students are gathered, away from their computers, to discuss the problem situation. This usually lasts ten to fifteen minutes. In the second part, students are at their computers or working with classmates. This part should be mostly self-directed; students each decide for themselves how to use this time productively. You as the teacher circulate, asking and answering questions and engaging individual and small groups of students in discussion of their work.

If you are using a computer lab, make sure you are able to reserve it for the requisite number of hours (10 to 12 hours, which may be anywhere from 7 to 15 days depending on the length of the class period) within a four-week period. Less time than this will generally mean that you must skimp on class discussions or that some students feel rushed and frustrated at the end. You can spend additional days in this unit in the classroom, away from the computer lab. Lesson plans for those days are labeled “Extension Activities.”

The following lesson plans assume 45-minute periods for 15 days, with an extra day away from the computers for a wrap-up session. They will need to be adjusted accordingly for different length class periods.

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DAY 1

Main Task

Watch the Opening Scenario and become acquainted with the virtual environment.

Class Discussion

You may be tempted to provide "warm up" activities for students, such as telling them about the problem presented in *Alien Rescue* or discussing relevant vocabulary. Resist. Problem-based learning begins with the problem presentation. Students must sort the problem situation out for themselves and will acquire vocabulary naturally as they attempt to communicate about the problem.

Alien Rescue begins with students viewing the opening scenario. This can be accomplished in three ways:

Method 1	If you have access to a computer attached to a projector or a television, show the opening scenario to the entire class simultaneously. After they have seen the opening scenario, students should go to their assigned computers and log on.

Method 2	Select four to six students scattered around the class and have them login to their computers. Other students watch as they do so. When prompted “Do you want to see the Opening Scenario?” they click “Yes.” Students can watch the opening scenario on any of the computers playing it.
Method 3	If you have enough headphones for everyone, you can ask students to watch the opening scenario on their own computers. Note: this is not a good option if you cannot provide headphones. Since students will start at different times, the resulting noise will make it difficult to focus on the problem situation.

At Their Computers

Students should spend the remainder of the day exploring the virtual environment. Allow students to discover as much as they can on their own, and encourage them to share their discoveries with their neighbors. In this way, knowledge about the program will circulate around the class without any direct instruction on your part.

Teaching Tip: Passwords

Students must select a password when they first log on. Suggest that students write their passwords down or take a moment to memorize them. If they forget their passwords, they will have to create a whole new login. You may want to record the passwords students create, or you may ask students to quit the program then log back in so that they can be certain they remember their passwords.

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DAY 2

Main Task

Generate questions about the scenario and continue to explore the virtual space station to find answers.

Class Discussion

Start by asking what the problem is that students must solve. As students start to offer their ideas, ask a few questions about the events that created this problem. Here are a few examples:

Why do the aliens need new homes in the first place? What was the matter with their homes? *(A nearby star exploded; they realized the debris from that explosion would eventually reach their solar system and destroy their worlds. For more information on star explosions, read "Supernova" in the Science Topics for Class Discussions document.)*

If a star explodes, doesn't it destroy the surrounding planets quickly? How did the aliens have time to build their ships to escape? *(It wasn't the star in the alien's system that exploded. It was a nearby star. It would take many years for the debris to reach their system, so they had time to escape.)*

Why can't the aliens find their own homes? After all, their technology is more advanced than ours. *(Their ship was damaged. They can no longer collect the information they need.)*

Can we speak to the aliens? Can they help us to solve the problem? *(No. Their ship can no longer provide them with life support, so they have entered a state of suspended animation, where they must remain until they reach their new homes.)*

Why is the alien message in English? How did they learn to speak our language? *(They picked up our broadcasts, which are carried on radio waves. They deciphered our language well enough to write the distress call. To learn more about this topic, read the section "Radio Waves" in the Science Topics for Class Discussions document)*

Where are we working? Are we aboard the alien ship? *(No. We're aboard the international space station, Paloma. The alien ship is also in orbit around Earth, but we are not aboard it.)*

If we're not on the alien ship, why do we have their computer? *(It was moved there from the alien ship. It was decided that it's easier to work on the space station than on the alien ship.)*

Why didn't we simply bring the alien computer to Earth and work there? Why are we working aboard the space station Paloma? *(Students should speculate on this, as an answer is not given in the scenario. Some plausible responses are that we didn't want to take the chance of damaging the alien computer by bringing it to Earth, and that we have to be very careful about the possibility of bringing any foreign materials to Earth that may contain new germs and diseases. You can easily tie this latter reason into real life history, explaining how Columbus' excursion brought new diseases both to the Americas and Europe, resulting in many deaths.)*

You should ask some questions to get the discussion going, but encourage students to think about the problem situation and generate their own questions. Also, do not answer any of the questions yourself. Record the questions students cannot answer on the white board and ask students to look for the answers as they work today.

At Their Computers

Students should continue to explore the space station environment, trying to find answers to any questions remaining after the group discussion. Allow students to explore as they see fit. Some students will already be thinking about how to solve the problem; others will still be focused on what the various tools do. Different students

will figure out different things, which will help to enrich class discussions, and bring more ideas out early in the unit.

At some point during the day, ask students to look around the classroom to see what their classmates have discovered. Encourage them to request information from classmates that have discovered a part of the program they have not yet seen. By the middle of this class period, all students should have discovered that they can use the arrow keys on their keyboards to navigate the space station. If anyone has not discovered this, ask students who have found the alien computer or the probe design room to explain how they got there.

Teaching Tip: Probes

The part of *Alien Rescue* students generally enjoy the most is designing and launching probes. Left unchecked, some students would launch dozens of probes without planning them or evaluating their effectiveness. To deal with this problem, students are provided a budget for launching probes. This budget should be sufficient for most students to gather enough information to solve the problem. However, there may be some students who will run out of money and *Alien Rescue* will then pop up a dialog box requesting a code for additional budget funds. Students will not be able to proceed until the code is provided.

When this occurs ask them to consider the conditions under which they think scientists get funding to conduct research. Tell them that you will be discussing this in the next few days in class, and that you would like them to have some ideas to share at that time. Also, probe the student's thinking about how to construct a probe and why. You may be able to help the student build probes within the new budget constraints.

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Worksheet #1: The Problem Situation (Optional)

Several optional worksheets are provided in the Teacher's Portal. Four of these worksheets are writing assignments that can be done either in class or at home. The other four worksheets should be used in class as students are using *Alien Rescue.*

For all the writing assignments, the answers provided in this manual are only examples of appropriate responses and are given here only to help you guide class

discussions of these assignments. Students' answers will vary from these, so if you grade these assignments, you must evaluate their responses individually.

Assignment: *Write a problem statement. You should explain what the problem is and what caused it. Also, explain what conditions make it difficult to solve. This should be approximately 100 words long.*

Sample Response: The aliens need to find new homes, or they will die. They cannot find these homes for themselves because their ship was damaged. Their computer cannot search for homes, and their life support is not working. They are in suspended animation, and cannot wake up until they get to their new homes. They want us to find homes for them, but before we can we need to figure out what they need and find worlds that match their needs.

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DAYS 3 - 5

Main Tasks

Discuss students' ideas about the process they will use to solve this problem. Discuss the value of collaboration and encourage it in class. Identify the needs of each of the alien species.

Class Discussions

While class discussions during *Alien Rescue* should be flexible and build on students' comments and interests, in these early days you may need to direct the flow of conversation. Try to make sure to address the following issues during days 3 - 5:

1. *Problem Statement.* If you gave the writing assignment, let students share their statements. If not, make sure that students all understand the nature of the problem. Get students to describe what a solution will look like (a world for each alien species, for six worlds altogether). Also, if there were unanswered

questions from previous discussions, ask students to share any pertinent information they discovered.

2. *Problem-Solving Process.* Ask students how they think they will go about solving the problem. Get them to identify steps they will use in the process. Students may not clearly see their way through the entire process, but they should recognize that one of the first things they need to do is to figure out what the aliens need so they can find a world that matches those needs. Explain the importance of having a plan so as to work effectively and not waste time doing things that are not helpful. Encourage students to consider what they will do before they actually log on.
3. *Collaboration.* Bring up the story of Dr. Frankenstein and the monster he created. Ask students if they can describe how he worked. Bring out of the discussion the idea that he worked almost alone, with only Igor to help him. Ask students if this is how scientists normally work. Get them to recognize that scientists usually work together, and explain how important it is for scientists to publish their findings. Get students to identify reasons for scientists to work together. Here are a few of the reasons they may generate:

- Many of the tasks scientists work on are difficult. It is impossible for one person to do everything alone.
- When scientists share new ideas, they inspire other scientists to come up with new ideas as well. In this way, scientists build on the work of others.
- There are many "bright ideas" out there; when scientists work together, they have more bright ideas to work with, and can come up with better solutions or understanding.
- Working alone gets dull after a while. Science is much more exciting when you have others to share with.
- It takes time to do all the things scientists do. If they collaborate, they can divide up the work and do it faster.

1. *The Way Scientists Work.* As students discuss problem-solving and collaboration, explain that this is similar to how real-life scientists work. Explain that as they work on *Alien Rescue,* students are going to work the way scientists do – collaborating, investigating, making hypotheses, testing them, and sharing their findings.
2. *Aliens' Needs.* Support the students in coming up with a list of the needs of each species. You may want to put a chart on the white board and devise a plan whereby students take turns filling in needs (see the Alien Needs tables within the Teacher's Portal in the Printable Pages and Documents Section: Program

Materials and in The World of *Alien Rescue*). It is best not to write this yourself as students call out answers, as this moves rather slowly and becomes somewhat tedious. Help students to refine these lists by asking them to review the list for one species together. To do so, get students to look for items in the list that may not represent needs. For example, if one item about the Jakala-Tay is "has a long tail," students should be able to argue that the appearance of a species is relevant to what they need in a new home. Encourage students to review their notes and make changes based on these lists. Begin to explore with students why certain factors represent needs and to compare the species with humans. For example, you could ask the following

- Why does gravity matter? What effect would it have if you were to go to a world with more gravity than your home world? *(Our muscles develop to handle the gravitational pull of our home world. If we moved to a world with more gravity than we're used to, we would find it difficult to move or even breathe. If we went to a world with less gravity, our muscles would lose strength, or atrophy, and it would be difficult for us to return to our home world. For example, some Russian cosmonauts have spent months in space. When they return to Earth, they cannot even walk at first because their muscles have lost so much strength. For more information, read "Gravity" on the Science Topics for Class Discussions page.* Do you know any worlds with a lower gravity level than Earth? *(There are no terrestrial worlds with higher surface gravity than Earth. Jupiter, Saturn, and Neptune have higher gravity levels, but this is deceptive because they don't have hard surfaces, so they don't have a surface gravity level.)*

- Why might an atmosphere be important to a species? (*respiration, protection from meteors, keeps heat from escaping into space)* What is Venus' atmosphere like? *(pressure is high enough to crush you, thick, cannot see through it from space, has a greenhouse effect which makes Venus very hot)*

- People can build things. In addition to intelligence, we have another essential characteristic - opposable thumbs. Without them, we could not hold tools, and without tools, we would not be able to build. Which of these species build things? *(the Eolani, the Jakala-Tay, the Kaylid, and the Sylcari)* Can they all hold things? How? *(Get students to look at the pictures of these species and offer opinions)*

1. *Science Topics.* A few topics will naturally arise as learners deal with making sense of what they learn about the aliens. Try to let these questions arise naturally in class rather than introducing them yourself, but make sure they are addressed at some point during the program:

- What are the pictures with brightly colored lines that are in the alien computer? *(These are spectra. Every substance has a unique spectrum, meaning that we can tell what something is made of by looking at its spectrum. In this way, spectra are like a "signature" for an element. Scientists can tell what stars are made of by looking at their spectra. For more information, read "Spectroscopy" on the Science Topics for Class Discussions page.)*

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At Their Computers

Allow students to work as they see fit. Circulate among students, asking them what they are doing and their reasons for doing it. Some students will not have answers. Ask them to stop for a moment and think of a plan before they proceed, or ask a neighbor what he or she is doing. Try to make contact with them again later in the period. Do not tell them what to do, even if that means they are not very productive. A major goal of *Alien Rescue* is to encourage student ownership of their work, which they cannot do if you tell them what to do.

Students should spend most of these days reading about the alien species, and perhaps looking at the solar system database to find potential homes for each species. Many students will spend a substantial portion of days 3 and 4 looking at the probe design room. Through discussion, try to move them into an investigation of the alien species. But do not insist. These students will learn a lot about how to design a probe, and will be able to help other students later on. Also, before they can actually launch a probe, they will have to prove to you that they know enough about the needs of a species and have identified a world where it can live. So they will end up doing this work without your insistence or control.

Encourage collaboration. When students ask you for help, tell them to ask their classmates. You can even call out their question to the rest of the class and ask if anyone thinks they know the answer. If someone does, suggest that the student go over and talk to that person. If you refuse to be the source of information and ideas, students will begin to rely more on their classmates and themselves.

Worksheet #2: The Aliens

Students will need to have access to *Alien Rescue* in order to complete this worksheet, so this is for in-class use only.

Extension Day: Refining the List of Aliens' Needs

After students have generated a list of the aliens' needs, you may want to spend a day away from the game to further refine these lists. You can use the 1st version of the notebook to display the lists students generated as a whole class discussion. You can also divide students into five groups and have each group refine the list for one of the species.

Spend the remainder of the class session discussing why these items are needs. Why is temperature important? What difference does gravity make? Does it matter what substances are in the atmosphere? Does anyone know why a magnetic field is important? If humans were looking for a new home, what qualities would we look for in a world?

In addition to having the opportunity to discuss many science topics, this activity can help you to identify students' misconceptions and areas of weakness. This activity can also guide students to note what information they should take notes on. You can use this information to guide future class discussions both during *Alien Rescue* and later units.

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DAYS 6 - 8

Main Tasks

Look for possible homes for the species by searching the solar system database. Begin designing and launching probes.

Class Discussions

Discussion during these days will depend on what topics students bring up, so be flexible. You should try to touch on each of the following:

1. *Probes*

Ask students to share their ideas about the conditions under which scientists receive funding. Continue the discussion until students reach two conclusions. First, probes are expensive; we want to know that they will work properly and return valuable information. Second, you must have a reason to believe that the world you are investigating might be a good home for one of the alien species. In other words, you need to have a hypothesis to test.

2. *The Role of Hypotheses in the Scientific Method*

Students probably know what hypotheses are, but may have a shaky understanding of the role they play in science. Therefore, you may need to give a mini-lecture on this topic. Explain that hypotheses guide the work that scientists do. Scientists examine situations/phenomena and make educated guesses about them. They then design tests to determine if their guesses are correct or to collect additional information to enrich their understanding of the situation and refine their hypotheses. Get students to figure out what a hypothesis looks like in this situation. One good format is "I think the (species name) can live on (world name) because (reasons)."

3. *Science Topics*

Ask students to share any information they have discovered that they think will help to solve the problem. As they do, try to tie their comments to science topics. For example, if a student says that Jupiter has a magnetic field, ask why some worlds have magnetic fields while others don't. If a student says she thinks Europa might have water, discuss the importance of water on Earth, and why finding it elsewhere in our solar system might be so interesting to scientists. As students mention various moons, make sure they understand the difference between a moon and a planet, and ask them to name the planets and moons. There should be many opportunities to discuss scientific topics for the remainder of the program. Be sure to read "Science Topics for Class Discussion." This contains information you can try to work into class discussions. The following are a few possible questions you could ask to stimulate discussion:

- What is the difference between a moon and a planet? *(Planets orbit the sun, while moons orbit planets. Moons also orbit the sun in that they are carried along by their planet as it goes around the sun.)*

- We have two types of planets in our solar system. What are they? *(terrestrial and gas giants)* What's the difference between them? *(Terrestrial planets have hard surfaces, while gas giants are mainly made of gases. Gas giants have thick atmospheres and the pressure of the atmosphere increases as you go deeper into it toward the center of the planet. For example, if you sent a probe into Jupiter's atmosphere, it would eventually be destroyed by the high atmospheric pressure. Scientists believe that gas giants have solid cores, but there is no hard surface you could stand on.)*

- Venus is sometimes called Earth's sister planet, but it's so much hotter than Earth. Why? *(Students may venture that it's because it's closer to the sun. This has an effect, but the greenhouse effect of Venus' atmosphere is the real reason. Its thick atmosphere holds heat in, not allowing it to escape into space. This is the same thing that happens in a car on a hot day. An interesting fact to bring out is that Venus is hotter than Mercury, which shows just how important the greenhouse effect is.)*

- Io is an unusual moon. What makes it so different? *(It has active volcanoes)* What causes those volcanoes? *(Io is close to Jupiter, so Jupiter's gravitational pull is very strong. Io is also pulled by the other moons of Jupiter. As a result, Io wobbles in its orbit. This causes a great deal of friction, so Io's core remains hot. The hot core causes pressures to build up under the surface until finally volcanoes explode. For more information on volcanoes, read the "Geological Activity: Active and Dead Worlds" sections of Science Topics for Class Discussion. Of course, Jupiter pulls on its other moons as well, but because Io is closer to Jupiter than are Europa, Ganymede, and Callisto, the effect of this pull is more dramatic.)*

4. *Peer Modeling of Collaboration*

Be on the lookout for a pair or trio of students who are working together particularly effectively. During a class discussion, ask them to describe for the class how they are working. You will need to guide them through this. For example, ask “Do you work on the same species at the same time? Tell us how you would do that.” Get other students to describe situations where a classmate helped them. Refer to the previous discussion on the value of collaboration and the reasons scientists usually work collaboratively.

Teaching Tip: Designing Probes Effectively

Encourage students to think about their designs. The following are a few ideas about questions you can ask students when they begin to design probes:

Ask students to tell you a hypothesis (e.g. “I think the Jakala-Tay could live on Venus because it has sulfur in its atmosphere and it’s the right temperature.”).

Look at students' probe mission statements and ask them why they decide to send a probe to this planet.

Look at students' data. Most students will have malfunctions in the probes they have already sent because of design flaws. Ask students to share something they’ve learned from these mistakes. If they have not had malfunctions, question them about probe design. For example, you can ask “What type of probe would you put a seismograph on?” or “For a mission to Titan, what type of power source would you use?”

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At Their Computers

Students are generally very self-directed and focused by this time. If you have been firm in insisting that they turn to peers for support rather than to you, they should be doing this spontaneously by now. This means that most of your interactions with students will focus on discussing the design of their probes and typing in the code for funding.

Things can get rather hectic during these days, as students become obsessed with designing and launching probes. The following are a couple of techniques for dealing with their requests for your attention:

- Tell students that you are circulating in a specific order (e.g. going up one row then down the next, going in a clockwise rotation), and that they should have questions/requests ready for when you get to them. Tell them that you will not go out of order, so it is pointless for them to keep calling you over. If you choose to do this, then you must make a commitment to make a circuit of the room every ten minutes. That means that you simply cannot have extended

one-to-one discussions with students, and that you must pass students by who are not ready to talk to you. Students who are waiting for the authorization code will quickly become frustrated if they believe you will never get to them. Have students signal that they would like to talk to you by placing a marker on top of their monitors. That way, you only talk to students who want your attention.

- You may feel that some students need some support but will require more time than you can give them. Ask students who seem to be on track to spend ten minutes working with them. Continue to encourage collaboration.

Writing Assignment

Either duplicate the worksheet provided in Appendix D entitled "*Alien Rescue:* Problem-Solving Process" or have students copy the following:

Suppose you had to teach someone how to find a home for one species of aliens. What would you tell him or her to do? Make a list of the steps you are using to solve the problem in *Alien Rescue.*

Leave ten minutes at the end of class to discuss the assignment and give an example of writing steps in a process. Give students an example of a simple problem, such as waking up hungry in the middle of the night, or having a flat tire on a bike. Then give them a list of steps you would go through to solve the problem. If you think your students need it, provide a written example.

Worksheet #3: Worlds in Our Solar System

This worksheet should be used in class after students have had some time to start exploring the solar system database, but have not yet organized the facts they have learned – usually around day 7 or 8.

Worksheet #4: The Problem-Solving Process

This writing assignment can be used either in class or as a homework assignment any time after day 5.

Extension Day: Drawing the Solar System

This can be done without access to the computers, so if you are using a computer lab for *Alien Rescue*, you won't need to reserve it for this day. Write this assignment on the board or overhead:

Draw a picture of the solar system. Include the names of as many planets and moons as you can, and draw their orbits around the sun.

Get students into groups of two or three, and give each group a sheet of paper. At first, encourage groups to work by themselves, and then ask them to look at what the groups near them have done. Provide additional paper as needed. This should not be a competition. Instead, students should realize through this activity that groups remember more than individuals, and that groups produce better quality work because they catch each other's mistakes. Finish the class with a brief discussion of these strengths of collaboration. Also, you can assign students to create their own drawing of the solar system for homework, then collect these for a grade.

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DAYS 9 - 11

Main Tasks

Continue to develop hypotheses and test them by launching probes. Continue to interpret data gathered from probe missions and apply findings to the problem. Discuss the design of probes and the types of tools scientists use to gather data.

Class Discussion

Again, discussions will vary based on the topics students bring up. Try to touch on the following topics during these days.

1. Students' Problem Solving Process

If students completed the writing assignment above, be sure to discuss the steps they listed. If you chose not to make that assignment, elicit the same steps through discussion. Ask students if they have had any insights into how to solve this problem by listening to their classmates or by realizing that there was a better way to work than the way they had been. Explain to students that we become better problem-solvers by reflecting on how we solve problems.

2. Effective Design of Probes

Three probe design worksheets are provided in the Worksheets section, if you would like to use these to facilitate discussion. If you like, you could use one or two of these worksheets as a quiz. If you would prefer not to use the worksheets, draw on students' experience in designing probes to discuss design issues. Many students will have had malfunctions in the probes they have launched. Ask if any of them have figured out what caused these malfunctions. Ask students why NASA frowns on malfunctions and get them to recognize how costly mistakes can be and the importance of learning from them. Introduce the idea of constraints - reasons why you cannot do certain things and must do other things. Get students to identify some of the constraints in building probes, such as these:

- Certain instruments can only be used on landers because they must come into contact with substances to measure them. These include barometers, thermometers, spectrographs, and seismographs.
- Seismographs don't work on gas giants because they don't have hard surfaces.
- High gain antennas are better for missions that go further than Mars.
- Solar panels should only be used close to the sun. For missions that go further than Jupiter, a thermoelectric generator is necessary.

3. Data from Mission Status Center

Ask students about the data returned from their probes and how they interpret it. For example, ask what lots of jagged lines in the data from a seismograph means. For more information, see: How to Read Mission Control Data in the Printable Documents page of the Teacher’s Portal.

4. Science Topics

Continue this from previous days. Some possible questions you could ask are

- What are the Galilean moons, and why are they called that? *(These are the four large moons of Jupiter, and were the first moons besides our own discovered in the solar system. Galileo discovered them in 1610. To learn more about this subject, read "Galileo and the Moons of Jupiter")*
- Why is a magnetic field important to a world? *(A magnetic field protects a world from the solar wind. For more information on this subject, read "Magnetic Fields" in the Science Topics for Class Discussions document.)*

- Some worlds have a lot of craters while others don't. What cause craters? *(meteor collisions)* Why don't some worlds have craters? *(Actually, all worlds with hard surfaces probably have some evidence of cratering, but on some worlds craters are eroded. Winds, moving water, volcanic activity, and seismic activity can all help to erase the evidence of cratering.)* What do we know about a world when we see a lot of craters on it? *(It has not changed in millions of years. Therefore, it probably does not have liquid water, volcanic activity, seismic activity, or much of an atmosphere.)*

At Their Computers

Students should be launching probes and analyzing data most of the time, though they will still be using other program features flexibly as they see fit. Now that they have gotten some funding, things tend to become less hectic. You will need to continue to give funding, but you should have more time for extended one-on-one interactions with students. You may want to use this time to get students who are normally quiet during class discussions to articulate their reasoning for their work.

Worksheet #5: Probe Design

Use this worksheet in class after students have had some time to design probes. These early probes often have a number of malfunctions, so these worksheets will be more meaningful after students have begun to recognize the constraints involved in building probes.

Worksheet #6: How Scientists Work

Duplicate the worksheet in the Printable Pages and Documents page, or have students copy the paragraph below. This writing assignment can be done in class or as homework.

How do scientists work? Think about how you have been working during *Alien Rescue* and consider how it is similar to the way you think scientists work. List at least four different facts you think describe how scientists work. For each fact, explain what you mean and why you think it's important.

Worksheet #7: Interpreting Data

You can use this worksheet either in class or as a homework assignment after students have begun attempting to interpret the data that is returned from the probes they launched. Wait to use this worksheet until students have mastered probe design.

Extension Day: The History of Space Flight

- There are several videos available on this topic, as well as books you can read aloud. You might tell students the story of how scientists have learned various facts about our solar system. For the early history of American Space Flight, look for books and films about Robert Goddard. Some videos you might consider are
- *Eyewitness Planets* by DK Publishing
- *Additional resources* @ http://core.nasa.gov

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DAYS 12 - 14

Main Task

Discuss and finalize decisions about where to send each alien species. Write rationales for these decisions in the recommendation form.

Class Discussion

Students may begin to feel pressured to finish, so they may want to spend less time in class discussion. Try to preserve discussion time, even if it means adding an extra day to the unit. The following are some topics to address:

1. *How Scientists Work* If you made the above assignment, have students discuss what they wrote. If not, still try to address this topic through discussion. Some possible understandings you may want to pull out are

- Scientists collaborate.
- Scientists make hypotheses, and these hypotheses guide their investigations.
- Scientists rarely get it right the first time. They make many mistakes and learn from each one.
- Scientists always back up their opinions with facts and data. They never simply say they believe something without being able to explain why.
- Scientists publish their findings. In this way they add to what other scientists know. Others can build on this information.

2. Deadline and Solution Requirements

Give students a deadline to complete their recommendations for each alien species. (If you are following these plans, it should be at the end of the 14th day.) The recommendation form requires students to enter both a world for each species and a rationale for that decision. You can require students to write a rationale for each species, or you can allow them to divide up the work, writing a rationale for just two species. Devise a plan to make sure that everyone does not do the same two species. For example, you can tell everyone to split them with a partner. Or you can ask for eight volunteers for each species, then list these on the white board. If you are going to grade this work, you can explain to students what you expect.

3. Proposed Solutions

Students should begin to share and debate which worlds make the best home for each species. Help students to articulate their reasons, getting them to refer to specific pieces of data they have discovered.

4. Science Topics

These days should provide ample opportunity to discuss scientific concepts. Use students' comments as a springboard for these discussions as much as possible. The following are some topics you should try to make sure are addressed:

- What would it be like to stand on the surface of a world that did not have an atmosphere? *(The sky would be dark, even when facing the sun. Atmospheres diffuse light; this gives us our blue skies on Earth. For example, pictures we have taken of the astronauts who have landed on the moon always show a black sky behind them. Second, we would not see any plant or animal life, because these things need an atmosphere. Third, we'd be more likely to see craters, because atmosphere helps to erase signs of cratering.)*
- What are three different scales for measuring temperature? *(Fahrenheit, Celsius, and Kelvin)* Why do we have three scales? *(They are used by different people. For example, Americans usually use Fahrenheit, while most of the rest of the world uses Celsius. Scientists use Kelvin because this scale is based on absolute o, the point where all motion in atoms stops.)* Do the scales measure different things? *(No, they all measure heat. A certain temperature would be called different numbers in different scales, but it would still the same amount of heat.)*
- Why is water so important to humans? *(Our bodies are composed primarily of water; we need to drink it.)* We do not know for sure yet that there is water on other worlds, but scientists think there may be. Do you know of any worlds that are likely candidates for water? *(Mars, Europa, perhaps Ganymede or Callisto)*

At Their Computers

All students should have launched several probes; it is time for students to begin submitting recommendations. On these days, the students should spend most of their time working on the recommendation form. They will need to go to other parts of the program to check their work, so they will be using various tools flexibly as they see fit. Engage students during these days in discussion of their recommendations, **asking to see their forms and read their rationales**. Seeing you emphasize this will help to move students still intent on launching probes forward to working on their solutions. It will also give you a chance to give one-on-one guidance and feedback, and help address any misconceptions students may have.

Worksheet #8: Science Topics

Duplicate this writing assignment or make a list of six to eight topics you have discussed during class discussions in *Alien Rescue*. List them on the board and give students the following directions:

Pick four of the topics listed here and write what you know about them. Make sure you write at least two or three sentences about each.

If you have decided to administer the Science Concepts Test, this worksheet can be used as a homework assignment and discussed during a review day before the test.

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DAY 15

Main Task

Finalize entries in the recommendation form and submit it. Teacher leads discussion of students' solutions. The class can view the ending scene of Alien Rescue (1-min: http://vimeo.com/90817308). Like the introduction to problem video, this is meant for you to show to class together on the last day to wrap up your AR. You can use it along with your class presentation/discussion. It does not provide answers to the problem (intentional).

At Their Computers

During the first twenty minutes of class, have students log on and make sure they have submitted their recommendation forms. If they do not, you will have no record of the rationales they wrote. Therefore, tell students to make sure they select a world for each species, and then submit the form even if they have not completed writing the rationales. Most students can finish in this amount of time, but if not, you will need to decide if and how to provide students additional time with the program.

Ask students to review which world they chose for each species, as you will discuss it after they have logged out of the program.

Class Discussion

Prior to class, make sure you have studied the elimination chart provided within the Portal and easily accessible in the the Printable Pages and Documents page, section on Alien Rescue Student Solution Form, Grading Rubric, & Elimination Chart. In particular, make sure you understand how to use the elimination chart, and are comfortable enough with it that you can use it easily during the class discussion. Save twenty minutes to discuss students' solutions. This should be a fun class. Call on one student to pick which species to discuss. Allow students to call out their solutions, and then tell them which worlds are the best choices and which ones are acceptable, but less ideal. If some students have selected a world that is clearly a poor choice, make sure that the problems with that world are pointed out. Continue with the other species until all are done.

Throughout this discussion, make sure that you communicate that there is no single right answer for each species. Rather, there are multiple good choices, as well as many not-so-good and downright poor choices. Make sure that the quality of a choice is judged by the ability to support it with facts, not by personal preferences.

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DAY 16

Main Task

Debrief the students by helping them to reflect on their experiences and share their learning. Administer the Science Concepts Test, if desired.

Class Discussion

The entire day is discussion, so students do not need access to computers. In you gave the writing assignment listed above, go through the list asking students to share what they have learned about various science topics. If you plan to study any of these topics in depth later in the year, point that out to students so that they make the connection. After discussing science topics, engage students with more general questions. Here are a few examples:

1. What did you think of *Alien Rescue*? Was this an effective way to learn science?
2. Do you think the way you worked resembled the way scientists work? In what ways? How was it different?
3. Are any of you considering a career in science? If so, do you have a clearer idea now of what scientists do?
4. Can you think of any real world situations where you might have a similar problem to solve? (One example you might offer is that one day students will probably want to find apartments for themselves. Explain how they will want to consider their own needs, and match them with the descriptions given in advertisements. Further explain that ads rarely give all the information needed, so students will have to investigate further by questioning the owner or manager and visiting the apartment.)
5. Did you learn any lessons in problem-solving? If so, what?

Extension Project

Alien Rescue touches on a variety of scientific topics well worth additional investigation. Have students brainstorm a list of topics they discussed during Alien Rescue, then identify which ones they would like to learn more about. Have students work individually or in pairs to research the topic and report back to the class.

Science Test

The Science Concepts Test is available in the Portal, within the Printable Pages and Documents page, section Worksheets, Tests, and Rubrics. Make sure that you understand the directions on this test, as it differs from those of a typical multiple choice test. Allow approximately 20 minutes.

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