

Lesson Plan

Assessment	AOL, Presentation
Cross-curricular	Business

Big Ideas

- Space exploration and the technologies that have been developed to facilitate it have had positive and negative effects on society, the economy, and the environment.
- Interactions among bodies within the solar system have an impact on the existence of life.

Learning Goals

- I understand and can use the terms: diameter, rotation period, spectral type, perihelion, inclination, minimum orbit intersection distance, and close approach in relation to asteroids and comets.
- I can use a database to research and identify asteroids and comets with particular characteristics.
- I can communicate ideas and plans using appropriate language in an oral presentation or video, as well as in a written report.

Specific Expectations:

A1.3 identify and locate a variety of print and electronic sources that enable them to address research topics fully and appropriately

A1.11 communicate ideas, plans, procedures, results, and conclusions orally, in writing, and/or in electronic presentations, using appropriate language and a variety of formats (e.g., data tables, laboratory reports, presentations, debates, simulations, models)

C1.1 analyse political considerations related to, and economic and environmental consequences (actual and/or potential) of, exploration of the solar system (e.g., political pressures underlying the original Space Race; the ability to monitor environmental conditions from space)

C2. investigate features of and interactions between bodies in the solar system, and the impact of these features and interactions on the existence of life;

C2.1 use appropriate terminology related to planetary science, including, but not limited to: solar system, geocentric, heliocentric, geodesy, geosynchronous, eccentricity, apogee, aphelion, perigee, and perihelion

Description:

In this lesson students will present a business plan to incorporate as a space mining start-up company. They will use a database to research and identify asteroids and comets that can be mined. This lesson will require at least 3-4 class periods to complete. **This lesson is intended for the university level.**

Materials/Resources:

Computers and Internet Access per team of 3
Presentation (Student)
Using the Jet Propulsion Small Object Browser
Investment Rating Sheet
Rubric
Additional Resources

Safety Notes

No safety concerns in this lesson plan.

Introduction

Students will create “companies” (3 per group). One class period is required for all of the presentations, which should be styled as business “pitches”. The teacher may wish to have companies compete for investments and each student should complete a rating sheet during the presentations (Investment Rating Sheet: See Link). The class can then choose one company in which to invest and this team may receive a prize or extra marks on the project. A rubric for the presentation and report is included for the teacher: Rubric (See Link).

Action

Presentations (See Link)

Considering the wealth of mining technology and expertise in Northern Ontario, you are well positioned to take a significant role in the newest type of mining venture – asteroid mining. With 3 of your colleagues, you have decided to incorporate as a space mining start-up company. This enterprise is not only risky, but also expensive and you must raise capital for your first big project. Your teacher and fellow students are actually venture capitalists that will decide which company in the class will receive funding. You must present your business plan including a report and slide presentation or video.

Your presentation and report should include:

A. Your company’s name.

B. The basic concept or business idea:

This is the company's overall mission. It could include mining for materials that can be used to refuel spacecraft travelling to the outer solar system or seeking water for astronauts on long space missions, mining resources that are valuable to sell on earth, or mining for materials to build space stations or colonies on distant planets.

C. Identify types and locations of asteroids to mine:

Come up with a list of criteria. You may wish to consult resources such as

https://en.wikipedia.org/wiki/Asteroid_mining and

<http://www.planetaryresources.com/2015/08/how-we-choose-our-asteroid-targets/>

Consider a variety of factors:

- If you want to mine a specific type of rock, metal, or mineral, you should do further research on different asteroid spectral types beyond C-type, S-Type, and M-Type
- If you are building a space station on Mars, your asteroid should be near Mars, whereas if you are bringing materials back to Earth, the difference in velocity between orbits is important since the spaceship has to “catch up” to return to the planet. Some companies are even planning to capture asteroids and extract their resources somewhere else.
- How large should the asteroid be? It may be easier to land on a larger asteroid, but it is easier to “hollow out” a smaller one.
- How soon is the asteroid's next “close-approach” to the Earth? Does it return regularly? Maybe you will plan to mine the same asteroid for 20 years or to mine one asteroid in 5 years, another in 20 etc.

D. Identify specific asteroids:

You may use the [JPL Small-Body Database Search Engine](#). For more information about using this database see ‘Using the Jet Propulsion Small Object Browser’ (See Link). Once you have chosen the target asteroids and/or comets, detail their desirable features.

E. What are some necessary tools and technologies for your company?

Are these technologies currently available? Being developed? Do you have ideas for new tools and equipment that could be invented?

F. Make some (very) rough estimates for a budget:

How much does it cost to launch 1 kg of water into space? How much money does it cost to launch a probe?

G. Why should the investor choose your company?

(Adapted from http://www.sciencebuddies.org/science-fairprojects/project_ideas/Astro_p038.shtml)

Consolidation/Extension

In a one-page reflection, analyze some political considerations related to, and economic and environmental consequences (actual and/or potential) of, asteroid or comet mining.

- Who owns the asteroids and comets?
- What could be some environmental consequences to mining in space?
- Are there other economic and/or social consequences to exploiting resources from space?

For possible answers:

The Problem with Asteroid Mining

<http://motherboard.vice.com/blog/the-problem-with-asteroid-mining>

The Promise and Perils of Mining Asteroids

<http://news.nationalgeographic.com/news/2013/130122-asteroids-mining-space-science/>

Mining in Space Could Lead to Conflicts on Earth

<http://nautil.us/blog/mining-in-space-could-lead-to-conflicts-on-earth>