Inquiry Topics About Space Exploration

David D. Thornburg, PhD
Executive Director, Thornburg Center for Space Exploration
dthornburg@aol.com
www.tcse-k12.org

The question is not, "What is the answer?" The question is, "What is the question?"
Poincaré

Question formulation lies at the heart of inquiry-driven project-based learning. It is unfair to expect students educated in traditional classrooms to develop good inquiry-type questions without the initial active support of their instructors. After gaining some experience with interesting questions, students are then able to find interesting topics on their own.

It is important to note that a base of prior knowledge is generally required for interesting questions to emerge. Toward this end, educators need to make sure students have a knowledge base sufficient to allow good questions to be formed. The challenge comes in knowing when to stop providing information, and when to have students formulate questions on their own. This challenge is made more complex when we realize that many learners come with a prior knowledge base of their own, especially when attending after-school programs in an area that already interests them. Concept mapping is a powerful tool for having students share their prior knowledge and conceptions of a subject area. Students who come with sufficient prior knowledge are more likely to formulate better questions than those whose maps show only a sparse amount of knowledge, or display mis-perceptions that need to be corrected before proceeding. Those students with rudimentary or inaccurate knowledge of a subject area benefit from some direct instruction or guided learning before being asked to formulate questions of their own.

Contents copyrighted, ©, by Thornburg Center for Space Exploration, 2008. All Rights Reserved.

Once a base knowledge of a topic is established, it is beneficial for students to evaluate inquiry topics before launching into the research phase of their projects. Toward that end, we have developed a simple rubric that can be used to assist in the evaluation of topics. (This rubric is on the last page.) Our rubric is based on six criteria:

- The answer is unknown to the student (and instructor)
- The answer is defensible
- The topic leads to deep research
- It can apply at any grade level, through college
- The focus is on understanding, not surface facts
- It leads to other interesting questions

The goal is not to apply the rubric blindly, setting a minimum "passing" score, but rather to use the rubric as a framework for thinking about the question and, perhaps, modifying it to make it more interesting and worthy of the student's time to answer it.

Alloted time is another attribute of inquiry-based activities. Some activities might be short projects (*e.g.*, one week) while others may extend over a semester or year. Guidance on question refinement can help get the scope of the project into alignment with available time.

The following list of questions meet some of the criteria explored in the rubric. These questions can be used to gain practice in the use of the rubric, or can be used by students who are initially having a hard time coming up with questions of their own. These sample questions span topics explored in the three years of our Space Exploration program. (Contact us for details.)

1. Why did it take until 1957 to design rockets that could send a satellite into orbit around the Earth? (STEM)
2. Why do planets have moons? (S)
3. Why are the inner planets (Mercury, Venus, Earth, Mars) terrestrial and the outer four (Jupiter, Saturn, Uranus, Neptune) gaseous? (SM)
4. Why do spiral galaxies and hurricanes have similar shapes when viewed from the distance? (SM)
5. How do we know what our own galaxy looks like? (SM)
6. Are there and equal number of left-handed and right-handed spiral galaxies (and is this significant)? (SM)
7. Why do spiral galaxies and hurricanes have similar shapes when viewed from the distance? (SM)

Contents copyrighted, ©, by Thornburg Center for Space Exploration, 2008. All Rights Reserved.

Rubric for evaluating questions:

Question: _____

Attribute	4 points	3 points	2 points	1 point	Total
Answer is unknown	Neither teacher nor student knows answer in advance	Teacher may have general answer for question	Teacher knows answer in depth	Student already knows answer in depth	
Answer is defensible	Highly likely to find solid evidence for an answer	Some existing research or other good sources are likely to be found	Very little reliable information exists	Results likely to be virtually impossible to verify or defend	
Leads to deep research	Topic supports wide range of connections to the content area	Topic has broad expanse but not tremendous depth	Topic provides limited opportunities for research	Topic provides no opportunities for deep exploration	
Can apply at any grade	Topic worthy of research at all levels, K-college	Topic limited to K-12 range	Topic germane only to student's grade level	Topic suitable for grade level below that of the student	
Focus is on understanding	Leads to deep understanding of topic area	Leads to understanding germane to the specific question only	Leads to answer based on surface knowledge	Leads to answer based on rote information	
Leads to other questions	Topic triggers numerous other interesting questions	New questions are limited to refinements of the original question	Very few new questions are suggested by the topic	No new questions are likely to emerge during the course of exploring the topic	

Contents copyrighted, ©, by Thornburg Center for Space Exploration, 2008. All Rights Reserved.