Cultivating Curiosity

with Life in the Universe labs - LITU (*beta*)

About LITU

Life in the Universe (LITU) is supported by the John Templeton Foundation under grant number 58380. LITU is a series of activities to engage Middle School-aged youth in the exploration of the search for life elsewhere in the Universe. Youth are asked to consider how finding such life elsewhere might be possible, and what it would mean for society. In order to reach a variety of informal learning environments, the curriculum is fully available on the web and starts with introducing students to basic astronomy content and asking students to examine how scientists know something to be true without it necessarily seeing it with their own eyes. A key component to the LITU project is to give students an opportunity to

generate their own questions to guide their pathway through the curriculum. When driven by their own questions on a topic, students are inherently motivated to explore the topic deeply and search for greater meaning and connection to their own lives.

LITU was developed by the WorldWide Telescope Ambassadors program and the Science Education Department at the Harvard-Smithsonian Center for Astrophysics.

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Introduction

Life in the Universe (LITU) inquiry labs are designed for use in informal, out of school time learning environments to draw student interest to STEM. Using a blend of hands-on activities, and computer visualizations through the WorldWide Telescope program, youth explore multiple aspects of the search for life elsewhere. In addition, students are asked to consider the societal implications for finding life elsewhere. While numerous out-of-school time projects have been developed to understand the search for Extrasolar planets, LITU stands apart for its efforts to engage students in considerations of what it life elsewhere would mean for our larger society from a theo-philosophical angle.

As in-school science classes have become more and more focused on specific learning targets, the opportunities for self-directed exploration in science have decreased. LITU aims to engage students in the PROCESS of Science - understanding the context, learning to ask open-ended questions and then investigating how one might go about attempting to answer such questions.

For students ages 10-13

Learning Goals

- Expose students to general concepts in astronomy (e.g. Solar System and stars)
- Practice asking questions and pose questions to investigate the theme further
- Think about what it means to be a "Citizen of the Universe"
- Explore Big Questions that are on the minds of scientists and philosophers like "Are we alone in the Universe?" "Might there be life elsewhere in the Universe?" "Should we be looking?" Throughout this guide, look for the "BIG Questions" section for suggested topics for getting students to think deeply about the topic from a broader context.

Getting Started

The role of the instructor in LITU is primarily to serve as a model learner and investigator-guiding students through the process in a way that supports their deep thinking about the how and why of the topics. Don't let the science involved intimidate you - LITU breaks the curriculum down into easy to understand, bite-sized pieces so that individuals without a background in science can engage students in the process of science. The following activities are listed in the order that we found to be most logical and effective. Feel free to use only some of them to meet the needs and goals of your students.

What is WorldWide Telescope (WWT)?

WorldWide Telescope (WWT) is a free computer program that enables students to explore the universe in incredible detail. WWT compiles the best imagery from telescopes all over the world into rich 2-D and 3-D maps of the sky, across the whole electromagnetic spectrum.

Students can manipulate and interact with the program, visualizing almost everything we know about the universe in ways they never could before. Users create "tours", or scripted pathways, through the Universe to guide users through specific views and for storytelling purposes.

How do I run the WWT tours?

Download WWT for **free** from worldwidetelescope.org.

(Original content for this lab currently runs in Windows only version of WorldWide Telescope. Video versions coming soon!)

Download resources linked throughout. WWT tour files have (.wtt) extensions.

Double click on the **.wtt** file to open and run the tour

LITU Resources

The full resource collection can be found in the K-12 Lesson Plans section of wwtambassadors.org website or at: https://tinyurl.com/wwtlitu

You'll also find:

- Day-by-Day Slide Deck (google and .ppt) to guide students through each session
- Student activity packet (.pdf)(.docx)
- WWT tours referenced throughout curriculum guide
- Capstone project templates

Discussing BIG questions

Included throughout the curriculum you'll find BIG questions for discussion. The goal of these questions and the ensuing discussions is to have students explore moral, ethical, and cultural challenges that the search for life elsewhere entails. The instructors should serve as a facilitator who models respectful discourse among students. You may find it useful to work with students to establish group norms for these discussions (eg. only one person speaks at a time, challenge ideas - not identities). Use some or all of the questions included based on your comfort or create your own.

LITU Curriculum Overview

Session		Activity	Details
1	LITU: WHY & HOW	**Great Wind Blows**	Examining what is seen and unseen, testable
		Draw the Universe	Small groups draw “the Universe”
2	ASTRO BASICS	**Astronomy Basics**	How do solar systems work, what do we know from our Solar System
		Your Cosmic Address	How are we situated in the universe?
3	ASKING GOOD QUESTIONS	**Beyond the solar system**	Use WorldWide Telescope software to explore what’s beyond our Solar System
		Using the Question Formulation Technique (QFT)	Learning to ask questions is a process to be practiced. Closed vs. Open Questions and Prioritizing questions
4	RESEARCHING TO ANSWER YOUR QUESTIONS	**Science involved in looking for exoplanets**	Where are the exoplanets we know about and how do we know?
		Creating a capstone project	Using a common format for presenting your research
5	USING EVIDENCE FOR SUPPORT	**Where can life exist**	What constitutes life?Where can life exist?
		Capstone	Why are you responding to this question?
6	LIMITATIONS OF SCIENCE	**What are the obstacles?**	Within each subgroup, investigate the challenges and limitations of our current understanding
7	ADDITIONAL REFLECTIONS	**Research**	Does your evidence stand up?
8	CONCLUSIONS	**Assemble Capstone**	Finalize with images etc.
9	NEW QUESTIONS	**Future questions**	What else do you want to know? What other questions or concerns arose?
10	SHOWCASE	**Share with others**	Pair should examine your presentation with the scoring rubric in mind

Sessions 1-4

Session 1: A Great Wind Blows (Icebreaker)

Core Concept: Icebreaker to get students moving and thinking of ways of knowing things

Materials & Setup: Chairs arranged in a circle facing toward the middle (or students seated in a circle on the floor, facing towards the middle of the circle.

Background: In traditional educational settings youth are exposed to lots of information that scientists already know. Throughout the LITU experience, we ask students to remain focused on "ways of knowing" as a means to engage them in the process of grappling with ideas that are not always consistent with one another.

Procedure: Playing Great Wind Blows

The game is simple to play; one person in the middle starts by saying "A Great wind blows for everyone who…" and then says any characteristic that is true for that person.

For example, if the person has been to Mexico before, he or she can say, "Great wind blows for everyone who has been to Mexico." All players who have been to Mexico before must stand and quickly find a new seat that is more than 2 chairs away from them. If the player is not able to find a vacant seat, he or she is the new person who is in the middle.

Concrete/visible examples:

- A great wind blows for everyone who has on blue jeans.
- A great wind blows for everyone with brown hair.

Abstract/unseen examples:

- A great wind blows for everyone who has been to Mexico.
- A great wind blows for anyone who likes chocolate ice cream.

Spend 5-8 minutes playing the game, then discuss BIG questions as a group.

BIG questions to consider: Which things were easy to tell right away? Which things did you need more information to determine? What would it take for you to be convinced that something unseen was true (i.e. what constitutes evidence)?
Which kinds of questions are you comfortable asking and answering? Which things can be proven and which things rely on trust? What are some other ways of knowing?

Session 1: Draw the Universe

(Activity planning sheet on the following page)

Core Concept: What do students think of or imagine when they think of "the Universe"?

Materials & Setup: Planning document (following these instructions and in the student activity packet); Large paper (bulletin board paper is great); markers/crayons;

Background: When most people think of the Universe, they generally start from their own experiences. This activity asks students to commit the ideas they have to paper through drawing and grapple with understanding how things relate to one another. Most will draw our Sun (a star) and the planets they know about. The size of these objects in relation to one another and the larger Universe are generally unfamiliar.

Procedure: Arrange students in groups of 2-3. Each group should have a large piece of paper - at least 3' long/wide and a set of markers.

> **Instructions to students:**
>
> *Sketch a picture of what you think "the Universe" looks like. Include and label objects that you think are part of the Universe, and how you think they are placed relative to other things.*

- Groups spend 3-5 minutes discussing what they will include and jotting ideas down in the boxes titled "Thinks we should include in our drawing" and "How we will organize objects on the page"
- Spend 15-20 minutes drawing, labeling and discussing. If students express that they are finished, encourage them to label, add detail and start to think about things they are unsure about including. Students can list things that they've heard of but aren't sure how to include in the box titled "We want to know more about"
- Debrief/discuss: What did you include? What questions did you have? Who included things outside of the solar system? What's something that you've heard of but have no idea how to fit it into your drawing? If you could create a 3D model what would you have added? Add a few ideas of what you'd change or add into the final box on the activity sheet.

BIG questions to consider: What is MY place within the universe? How do we know what we do about the universe? Where did the Universe come from? What stories have you heard about the origins of the Universe? What principles do scientists use to try and tell the story of our Universe? What are other ways of exploring our Universe that are cultural or tied to religion?

Drawing the Universe - Plan your drawing

Things we should include in our drawing

How we will organize the objects on our page

We want to know more about…..

We would add or change….

Session 2: Your Cosmic Address

(Activity sheet on the following page)

Core Concepts: We are part of something so big that it's hard to conceptualize how we fit in

Materials & Setup: Cosmic Address activity sheet

Background: As we think about what else is in the Universe, we need to first understand how we fit into the universe. Many students do an example of this in early elementary school and intentionally pointing out the scale of our worldview is limited to those closest around us.

Procedure: Start by asking students to fill out as much of the Activity sheet (on the following page) as they are able. Encourage students to complete the remainder as they progress through activities. Reassure students that they'll get more information as you share the first WWT tour.

BIG questions to consider:

You are one person- How many are in your family? How many people live in your city? What about your country? How many people live on Earth? How many planets in our solar system? What about outside of our Solar System? How many Solar Systems are there? With this knowledge of our solar system, what do you think about your own place within the universe?

My Cosmic Address

Before we explore the possibility of life elsewhere in the Universe, it's important to think about where you are right now, right here on your home planet. If there were a creature on another world who wanted to write to you, where would they send the letter? What's your cosmic address?

Here's a quick reminder for your galactic post office.

Your Name: _____

Your Street:_____

Your Town or City: _____

Your State: _____

Your Country: _____

Your Planet: _____

Your Position in Your Solar System: _____

Your Star: _____

Your Galaxy:_____

Based on "Other Worlds Student Guide," Science Education Department, Harvard-Smithsonian Center for Astrophysics

Session 2: Introduction to Astronomy - Our Solar System

Core Concepts: What is Astronomy? What do scientists know so far about our place in the universe? How is our planet situated in our Solar System?

Materials & Setup: Laptop with WorldWide Telescope (WWT) software installed. Depending on the size of your group, a projector may be necessary to show the tour created with WorldWide Telescope (WWT); internet access. Download the WWT Tour titled "**Our Solar System**" and open in WWT.

Background: Now that students have considered what they already know about the Universe, the next step is to visually explore what scientists have learned so far using virtual software and physical models to represent what is in the Universe and begin to explore astronomical objects (planets, stars, galaxies), their motions (rotation and revolution), and the size and scope of the Universe (how it all fits together). How do planets move relative to their stars?

Solar Systems: Our star is the Sun. Eight planets (including Earth) and dwarf planets (including Pluto) all orbit (or go around) the Sun, which is at the center. Planets are held in the solar system by gravity.

Earth's motions:

> Rotation: The Earth **rotates** around it's Axis. Half of the Earth is always lit by the Sun. This motion is why we experience night and day. When we see "sunrise" it's because our part of earth has rotated into the half of the Earth being lit by the Sun.
>
> Revolution: The Earth also **revolves** around the Sun. It takes 365 days (or one year) for the Earth to complete one orbit.

Procedure: If necessary, connect laptop to a projector so that all students are able to view. Once you've downloaded the .wtt file, open it and press play.

BIG questions to consider: Astronomy is a branch of science, think about the goals of this field of science. What is this science attempting to understand and how do scientists go about doing this? What are other fields of science investigation that are related to this search? What fields focus on things that can't be answered by science? Think about how we experience day and night on Earth. Is the experience the same in all parts of Earth? Might it be different if you live somewhere else (length of day/night and season change)? How so?

Session 3: Beyond our Solar System

Core Concepts: Our planet orbits our star, which is one of billions of stars in the our galaxy, the Milky Way.

Materials & Setup: WWT tour components - **Beyond Our Solar System Tour**

Background: We use our understanding of what's in our solar system (from prior activity) to help us understand the larger universe and give clues about how other solar systems are structured. Students begin to explore the ordering of planets in our Solar System. The planets closest to our star are smaller and "rocky". Those beyond Mars are "gaseous" and have no surface upon which people could stand. Pluto is one of hundreds of objects in our Solar System that is not big enough to be considered a planet. Pluto is situated among a number of other objects that make up the Kuiper Belt - if we still considered it a planet, we'd need to consider more than 200 other objects planets too!

Procedure: Download the WWT tour titled "Beyond our Solar System" and open it in WWT for viewing. Before viewing, remind students to reflect on what they drew as "the Universe" in session one. Ask them to recall what they included in their drawing. Advise students that they'll now use the WWT tour to become more familiar with the following:

- Beyond our solar system there are OTHER STARS
- Other stars have their own solar systems containing planets
- Groups of stars that move collectively make up a galaxy. Our galaxy is the Milky Way.
- There are hundreds billions of stars in the Milky Way. The Milky Way is one of hundreds of billions of Galaxies in the Universe.
- Scientists have mapped many of them

BIG questions to consider:

What was surprising to you today? Consider that humans have always sought to understand our place in the universe. Each society has it's own origin story- what origin story do you know about? Within our group, how many different origin stories emerge in discussion? How would or could we go about trying to determine which story is factual? How do scientists construct the "origin" story that makes it's way into our textbooks?

Session 4: Learning to Ask Questions

(Activity sheet on the following page)

Core Concepts: Asking questions is a skill, but one we are seldom taught. Learning to ask questions can help us to better understand what we know and don't know. For extensive information on the method used, Question Formulation Technique (QFT), please visit: http://www.rightquesiton.org/about/history

Materials & Setup: Markers & large pieces of paper. Divide students into groups of 3-5. When considering the student groupings, remember that students are most invested in exploring ideas when they choose their own group mates. If possible, allow students to determine their own groupings.

Background: Standard classroom practices involve teachers asking all the questions, and students answering a pre-selected subset of those questions about a narrowly defined topic. When we're given an opportunity to generate our own questions, we're more engaged in the process of answering them. This

Procedure:

Part 1:

Divide students into small groups. Once they are situated, introduce the Question Formulation Technique (QFT). The groups will respond to a prompt, or "QFocus" by asking as many questions as they can. Each group will choose a *scribe (someone who can write quickly and clearly)* to record all the questions.

They'll follow four rules:

1. Ask as many questions as you can
2. Do not stop to discuss, judge, or answer any of the questions.
3. Write down every question exactly as it was stated.
4. Change any statements into questions.

Tell the students they will have 5-7 minutes to complete the task.

Write this QFocus on the board:

"My fellow humans are searching for Life in the Universe"

Set a timer for 5 minutes. Start timer. As groups of students begin to compile lists of questions, encourage them to stay within the rules and focus on getting as many questions as they can. If you find a group stalled, reading the questions back to them aloud can prompt additional questions. If they're really stuck, model by thinking aloud

with some of your own questions. When time is up, congratulate students on the effort and number of questions they asked.

Part 2:

Label questions as Open (O) or Closed (C). Closed questions are ones that can easily be answered with yes/no or fact finding. Open questions are those that require an explanation. If time allows, ask students to change two of each type of questions into the other type.

Part 3:

Prioritize the questions. Students individually list their 3 most important questions and answer the question: Why did you choose these three as most important?

BIG questions to consider:

A lot of the questions generated are connected to science. As a group, share out questions that fall in the realm of science, and those that fall into other realms. Which questions have quantifiable answers? Which are not possible to answer? If science is one "way of knowing", what are other ways of knowing? (e.g. religion, cultural beliefs) What influences our ways of knowing in different environments?

What are some of the things we need to consider (beyond the science involved) about the search fo life elsewhere? On Earth, humans draw lines between themselves (e.g. cities/states/countries) - is it possible to create boundaries of this kind in outer-space? Who would be responsible for making such decisions? What if there is disagreement about the boundaries?

LITU - Question Formulation Technique (QFT)

Step 1 - Generate Questions (on a separate sheet of paper)

Rules:

- Ask as many questions as you can
- Do not stop to discuss, judge or answer the questions
- Write down every question exactly as it is stated
- Change any statement into a question

Step 2 - Label Open and Closed Questions

Step 3 - Prioritize Which of the questions you listed are you most interested in learning more about. List them below.

My priority questions for research:

1.

2.

3.

I interested in this topic because

_____

_____

_____

_____

Planning Capstone Projects

A note to instructors on proceeding

The first four sessions were organized such that all participants engage in the same set of activities to establish a common foundation of astronomy knowledge. The remaining 6 sessions are organized for small-group work and project-based learning. Student Activity packets are included to guide students in gathering information and planning presentations. Feel free to use the google slide deck we've created to help you organize, or create your own. From this point the curriculum can branch in a variety of different directions. As with most project-based learning, a fair amount of independent work proceeds from this point, guided by students' independent questions. Students are working to develop 21st century skills - researching a topic, supporting with evidence, and delivering findings in a presentation using google slides (or equivalent software). The activities in the following section are meant to be used as an outline of resources based on the five themes or "pods" that emerged from student questions during the QFT exercise.

We've grouped the collections of resources available in WWT tours into Pods
(Full descriptions on pages 22-26):

- **How we are looking for Life Elsewhere**
- **Can we Communicate**
- **What is Life**
- **How to Survive**
- **What if we find life?**

Students in our implementation created capstone projects using google slides, as chrome books available. The method you choose for students to create capstone projects should match the resources and goals of your program. For example, if resources are art specific, capstone projects could be original art pieces that incorporate the science and Big questions explored. Should you decide to have students create a google slide show, templates are available to organize thoughts for clear presentation. A showcase event where students present their slides with one another or their family and friends is a meaningful way to celebrate the effort and experience. We encourage you to modify the capstone to fit your students and needs.

Organizing Sessions 5-10

Each of the following subsections is an overview of what is covered in each remaining session. The google slide deck contains the same information detailed below, but in a slide-by-slide format.

Session 5 - What's the Science involved in answering our quesiton?

Divide students into small groups (2-3 members). The groups need to be able to work well together on a project for the remaining sessions. The first step in planning the capstone projects is to have students:

- Share their priority questions with one another
- Agree as a team on the **primary question** you'll investigate
- What interests you /get excited about your question?
- Begin to explore science ideas relevant to your question (use resources from Pods 1-5)

Session 6: Support your understanding with evidence

Continue to build on the explorations started in session 5. As students investigate the science concepts necessary to attempt to answer their question, encourage them to jot down the essential ideas they want to convey about the kinds of research they'd need to do to go about answering their group's question. Encourage students to keep a running list of new questions that arise while they're focused on their primary question.

Session 7: Connect the Science you've learned to your question

As a large group watch the video "How Small are we in the Scale of the Universe"to explore our size relative to the universe. With this perspective, we ask them to integrate this knowledge of scales and distances into their investigation of their question. **"How Does what I know about Scale and Distance connect to my Question?** Students create a slide to show their response.

Session 8: Reflect

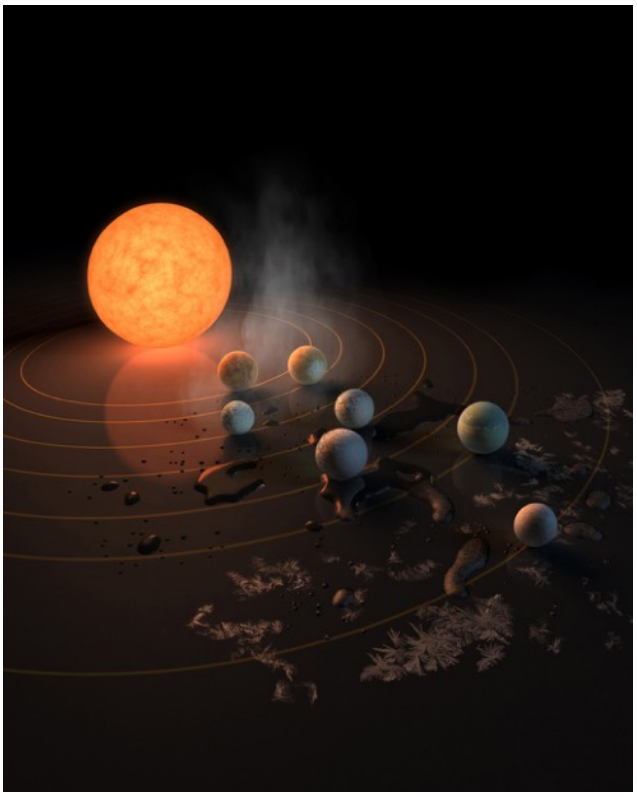
As students dive deeper into their investigations, and more questions arise, we ask students to grapple openly with "Big Questions". Students watch the video titled "Should we be looking for life elsewhere in the Universe?" Ask students to consider the points raised in the video that relate to their own question. Encourage open discussion and disagreement on these ideas: What is my opinion? Who might have a different opinion? Whose thinking matters in making these decisions? What other ideas are important to consider when exploring your questions? What would finding an answer to your question mean for humanity, culture, and our society? Following discussion, students add a slide to their capstone presentation that shares at least one of these reflections.

Session 9: Generating additional questions

As students are wrapping up their research, they'll likely have generated additional quesitons. Ask all the groups to take a step back from the individual quesiton they've been focused on. Engaging with the Question formulation technique again, with a related prompt will likely generate a richer set of questions than initially generated. This happens because students have been actively exploring topics in the prior sessions, therefore generating additional understanding.

Project this QFocus (statement + image of artists interpretation of Trappist 1 star system) and follow the steps outlined in activities in Question Formulation Technique (p.14):

Astronomers have discovered a star system that is 40 light years away. It has 7 Earth-like planets.



Session 10: Draw conclusions & prepare to share your investigations

Students have spent the past few sessions investigating their questions and the science involved in attempting to find the answers. Session 10 gives students the opportunity to integrate the commonly used Claim, Evidence, Reasoning (CER) format to summarize their investigations.

Examples of claims are:

- "I <do> <do not> think there is life elsewhere in the Universe."
- "I <do> <do not> think we will be able to communicate with life elsewhere in the Universe."
- "I <do> <do not> think we should try to travel to habitable planets."
- "I <do> <do not> think it will matter to me if we find life elsewhere in the universe."

Ask students to make a claim, reference the evidence they gathered while doing their research and share how their evidence supports their idea. The students record share this information in the "Conclusions" slide of their capstone project.

(Optional) Ask students to cite the resources you used. If the resources were from the web, students should include a link back to the url

(Optional) Practicing how you'd describe or share your capstone project with others

Showcase your work and Celebrate

We encourage you and your students to work together to share these investigations with one another, family and friends. Presenting the investigations and communicating why students are interested is a key 21st Century Skill. The format you choose to showcase the student presentations is entirely up to you. Celebrations can include students presenting their work to one another in a casual setting, sharing at an already organized Out of school time showcase, or as part of a presentation to an audience of your choosing.

Pod Collections by topics

Pod 1: How are we looking for Life Elsewhere?

Core Concepts: Astronomers understand that our solar system is one of many, and are using what they know about our solar system to guide what to search for planets elsewhere

Materials & Setup: WWT tour "How are we looking for life"

Background: Planets that orbit stars other than our sun are called Extra-solar Planets or (Exoplanets). While there are a number of methods used by scientists to detect exoplanets (Radial Velocity, Transit Method, Micro-lensing and Direct Imaging), the most accessible method for students to conceptualize is the Transit Method. The WWT tour compiles visualizations created within the software as well as those found elsewhere in video format.

Procedure:

Download WWT tour "How are we looking" and open in WWT. Students will explore the resource collection at their own pace and gather information to increase their understanding of the current search for exoplanets. Students record their findings in the activity packet provided as they plan for their capstone projects.

Resources:

Planet orbits	Edge on	The view from Regulus
Search for Exoplanets	Lightbulb & Horsefly	Intro to Transit Method
The Star Zulu Foxtrot	Transit Method Advantages	Transit Method Disadvantages
How we'll find Life	Planets that might have Life	Where should we look?
Kepler Orrery	How to get to Proxima B	

BIG questions to consider:

What if other solar systems aren't like ours? If astronomers can't "see" the other planets, how do they know that other planets exist? What are some areas in your life where we believe things to be true without actually seeing them? If you have multiple, plausible explanations for something, how do you decide which is true? What are things that could never be proven

Pod 2: Can We Communicate

Core Concepts: To figure out if we'd be able to communicate with life elsewhere we need to understand where the known Exoplanets are and what types of communication are possible

Materials & Setup: WWT tour "Can we Communicate"

Background: The Drake equation is a mathematical calculation of the probability that we could communicate with life elsewhere in the universe if we should find it.

Procedure: Download WWT tour "Can we communicate" and open in WWT. Students will explore the resource collection at their own pace and gather information to increase their understanding of whether we can communicate with life elsewhere.Students record their findings in the activity packet provided as they plan for their capstone projects.

Resources:

Location of Exoplanets	Mission to Alpha Centauri	
Should we be looking for Life	How to Get to Proxima B	Looking for Laser Beams
What if E.T. Calls Us?	Life and Purpose	

BIG questions to consider:

Along with the question of CAN we communicate, is the question of SHOULD we attempt to communicate. If scientists are able to determine a method of communication to attempt with life elsewhere, should they do so? What are some risks or rewards that this could invite? What should we as a human race attempt to communicate and why? Who gets to decide what is communicated? In what language would we attempt to communicate? Have we attempted anything like this that you know of? Should we disclose our location in the Universe? Why or why not?

Pod 3: How to Survive on Another Planet

Core Concepts: What would be necessary for humans to travel to and survive on another planet

Materials & Setup: WWT tour "How to Survive"

Background: Travel to another planet may be possible in your lifetime. Assuming this is possible, we'd need to determine the conditions necessary for human life to survive elsewhere. The resources in this collection are an introduction to life (as we know it) and considerations that would need to be made if humans were to decide to travel and attempt to live elsewhere.

Procedure: Download WWT tour "How to survive" and open in WWT. Students will explore the resource collection at their own pace and gather information to increase their understanding of whether we can communicate with life elsewhere.Students record their findings in the activity packet provided as they plan for their capstone projects.

Resources:

Three States of Water	The Goldilocs Zone	
Life After Earth	How to get to Mars	How to Survive on Mars

BIG questions to consider: Assume that we could travel to another planet. Why would we attempt to do so? Do you think this is a worthwhile endeavor? Consider what you have learned about colonialism (traveling to other lands and setting up colonies). How has colonialism impacted humans on Earth? What is the impact on the life that already exists in the lands being colonized? What are risks and rewards of attempting to live elsewhere? Have you ever moved to a completely new environment? What was difficult and what was exciting about it? Would you want to attempt to live on another planet? How does the prospect make you feel? Is it something that excites you or scares you? What elements of life would be the same as life on earth? What would be different? If you knew that you'd never return to Earth, would that change your mind?

Pod 4: What if we Find Life

Core Concepts: If we detect signs of life elsewhere, considerations of next steps will need to be made.

Materials & Setup: WWT tour "What if we find life"

Procedure: Download WWT tour "What if we find life" and open in WWT. Students will explore the resource collection at their own pace and gather information to increase their understanding of whether what concerns arise if we do find life elsewhere.Students record their findings in the activity packet provided as they plan for their capstone projects.

Resources:

Location of Exoplanets	Mission to Alpha Centauri	
How to get to Proxima B	Dolphins & Aliens	A Message from ET

BIG questions to consider:

Similar to the question of CAN we communicate, is the question of whether life detected elsewhere would be sentient (intelligent). What are signs of intelligence or civilization as we understand it? Who should decide what the next step is? Should this decision be made by scientists or the governments of various nations on Earth, or everyday people? What are some different perspectives that you think each of those groups may have and why? Is there a common language that could be used?

Pod 5: What is Life?

Core Concepts: Is life as we know it the only possible form of life?

Materials & Setup: WWT tour "What is life"

Procedure: Download WWT tour "What is life" and open in WWT. Students will explore the resource collection at their own pace and gather information to increase their understanding of what constitutes life.Students record their findings in the activity packet provided as they plan for their capstone projects.

Resources:

Three States of Water	The Goldilocks Zone	
Life's Basic Ingredients	Life on Other Planets	What will Life Look Like?
Extremeophiles	Slime Mold: Is it Alive?	

BIG questions to consider: Water is required for life as we know it to exist? If there's not water, could there be life? What do you imagine that life could look like? Think about the slime mold from the video resource - if it is alive, is it sentient (intelligent)? Why or why not? What are some ways that life on Earth has been impacted by the actions of humans? What is your relationship to other living things (plants/animals)? Considering that many mammals are able to communicate with one another and with humans, what are some ways that we, as humans, respect or disrespect other life?

Resources included:

WWT Tours for download

- Our Solar System tour: https://drive.google.com/file/d/1FAnQzLnT1kxR1Ivh-jmetr_Qf96Nsyd4/view?usp=sharing
- Beyond our Solar System tour: https://drive.google.com/file/d/1rwIrHUWiMSDX3X-XtYvrl9C75d4AzswT/view?usp=sharing
- How are we looking tour:
- Can we communicate tour:
- How to survive tour:
- What if we find life tour:
- What is Life tour:

Video resources

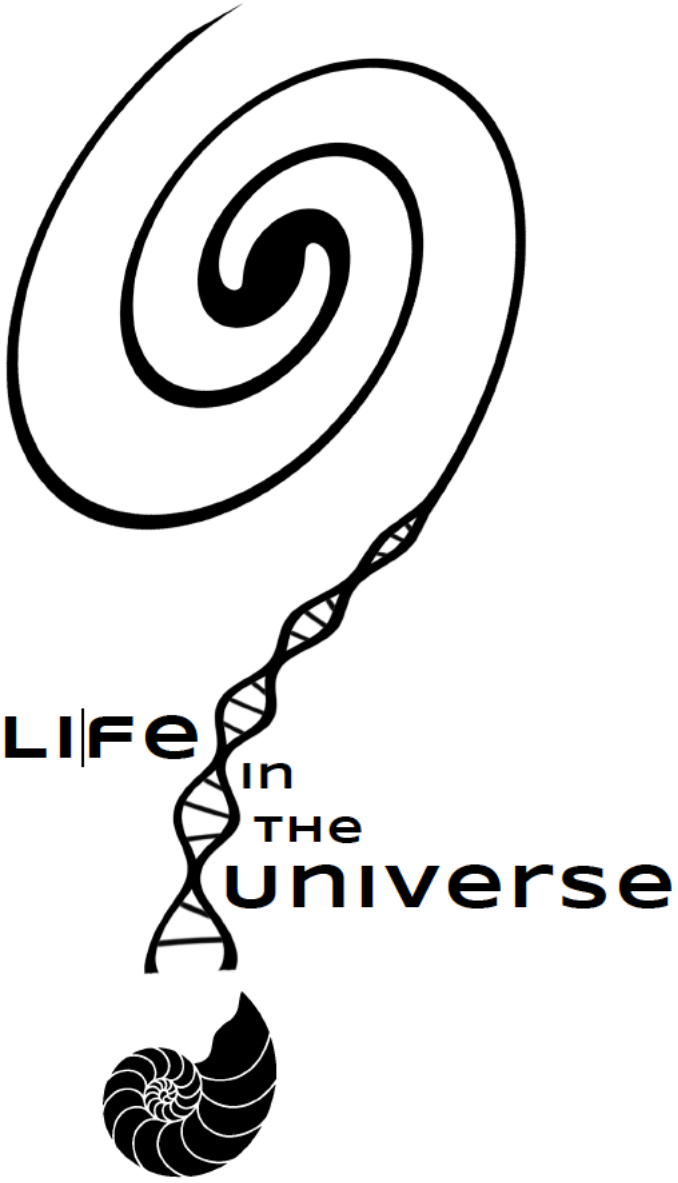
- Youtube playlist of all non-WWT resources: https://tinyurl.com/ybvmer68

Additional resources

- Other worlds/other Earths (advanced investigations) -https://www.cfa.harvard.edu/smgphp/otherworlds/OW/getting_started.php

Student Activity Packet

Names:_____



Draw the Universe - Plan

Things we should include in our drawing

(Roughly) how we will organize the objects on our page

We want to know more about...

Things we would add to our drawing or change

My Cosmic Address

Before we explore the possibility of life elsewhere in the Universe, it's important to think about where you are right now, right here on your home planet. If there were a creature on another world who wanted to write to you, where would they send the letter? What's your cosmic address?

Here's a quick reminder for your galactic post office.

Your Name: _____

Your Street: _____

Your Town or City: _____

Your State: _____

Your Country: _____

Your Planet: _____

Your Position in Your Solar System: _____

Your Star: _____

Your Galaxy:_____

Based on "Other Worlds Student Guide," Science Education Department, Harvard-Smithsonian Center for Astrophysics

LITU - Question Formulation Technique (QFT)

Step 1 - Generate Questions (on a separate sheet of paper)

Rules:
- Ask as many questions as you can
- Do not stop to discuss, judge or answer the questions
- Write down every question exactly as it is stated
- Change any statement into a question

Step 2 - Label Open and Closed Questions

Step 3 - Prioritize Which of the questions you listed are you most interested in learning more about. List them below.

My priority questions for research:

1.

2.

3.

I interested in this topic because

_____

_____

_____

_____

Question Formulation Technique is a method developed by The Right Question Institute: http://rightquestion.org/

LITU - Capstone Project Outline

Slides 1-3

Slide 1: Title - The Question our team is exploring

_____

_____

Slide 2: The reasons we are interested in exploring this question

1.

_____

_____

2.

_____

_____

Slide 3: Science relevant to our question

Resource we used:

_____

Science idea we learned that is related to our question:

1.

_____

_____

This idea is related to our question because

_____

_____

Resource we used:

_____

Science idea we learned that is related to our question:

2.

_____

_____

This idea is related to our question because

_____

_____

LITU - Capstone Project Outline

More science relevant to our question!

Resource we used:

_____

Science idea we learned that is related to our question:

1.

_____

_____

This idea is related to our question because

_____

_____

Resource we used:

_____

Science idea we learned that is related to our question:

2.

_____

_____

This idea is related to our question because

_____

_____

If you want to, write notes from your resources here:

Resource we used:

_____

Ideas:

_____

_____

_____

Resource we used:

_____

Ideas:

_____

_____

_____

Resource we used:

_____

Ideas:

_____

_____

_____

LITU - Capstone Project Reflections

Following the group discussion, summarize your reflections below and add another slide to your capstone project:

What is your opinion about whether we should be looking for life elsewhere in the universe?

What other ideas are important to consider when exploring your questions?

What would finding an answer to your question mean for humanity, culture, and our society?

Future Questions

Follow the Question Formulation Technique for the QFocus shared by the instructor.

Question Formulation Technique
Step 1 - Generate Questions (on a separate sheet of paper)

Rules:
- Ask as many questions as you can
- Do not stop to discuss, judge or answer the questions
- Write down every question exactly as it is stated
- Change any statement into a question

Step 2 - Label Open and Closed Questions

Step 3 - Prioritize

Which of your questions is most connected to the theme of your capstone project? Record these additional questions below and in your "Future Questions" slide.

LITU - Capstone Project Conclusions

Our Claim:

_____

_____

_____

Our Evidence:

1.

_____

_____

2.

_____

_____

Our Reasoning:

_____

_____

_____

_____

LITU - Capstone Project Checklist:

- ❏ My title slide has my name
- ❏ My title slide has my question
- ❏ My Why am I Curious slide has 1 reason I'm interested in the question
- ❏ My 1st science content slide is about the science involved in trying to answer to my question
- ❏ My 2nd science content slide is about science involved in trying to answer to my question
- ❏ My Reflections slide includes some personal or social thoughts relevant to my question
- ❏ My Future Questions slide has 1 **new** question about something you want to continue researching to learn more about
- ❏ My Conclusions slide brings my ideas together
- ❏ My credits slide (optional) has urls for the resources and images I used in my presentation