Inquiry, inquiry, and more inquiry:

My three experiences with *inquiry-based learning*

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ComSciCon 08/2021

Inquiry-based learning is teaching...

~~Traditional Lectures~~ Scientific Knowledge

~~Traditional Labs~~ Scientific Approach

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My three experiences with *inquiry-based learning*

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(1) ISEE Professional Development Program (ISEE PDP)

w/ Undergraduate summer research students (2019)

(2) University of Arizona Sky School

w/ Grade school students

(e.g. elementary school students in 2019 – 20)

Taught me inquiry-based learning

(3) Astronomy HWs in Major Courses

also w/ Undergraduates, but in classes (2020 – 21)

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(1) ISEE Professional Development Program (ISEE PDP)

w/ Undergraduate summer research students (2019)

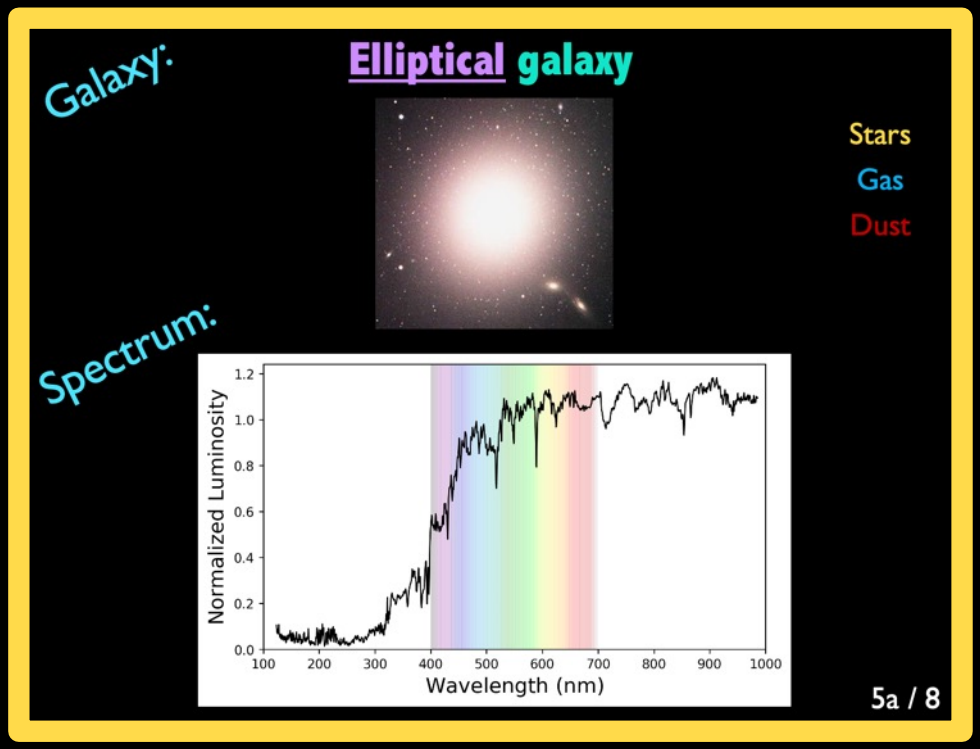
End Goal (for each group of three):

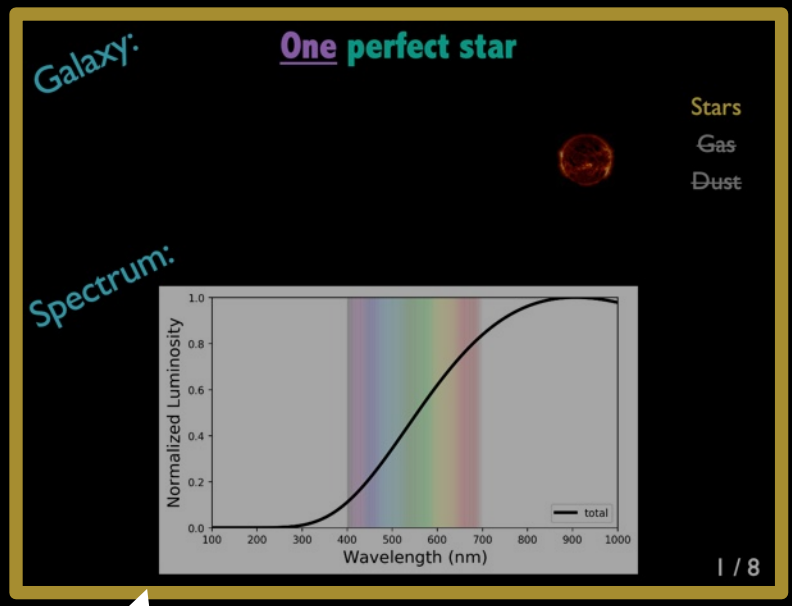
Design and teach
a full-day inquiry activity focused
on a learning goal.

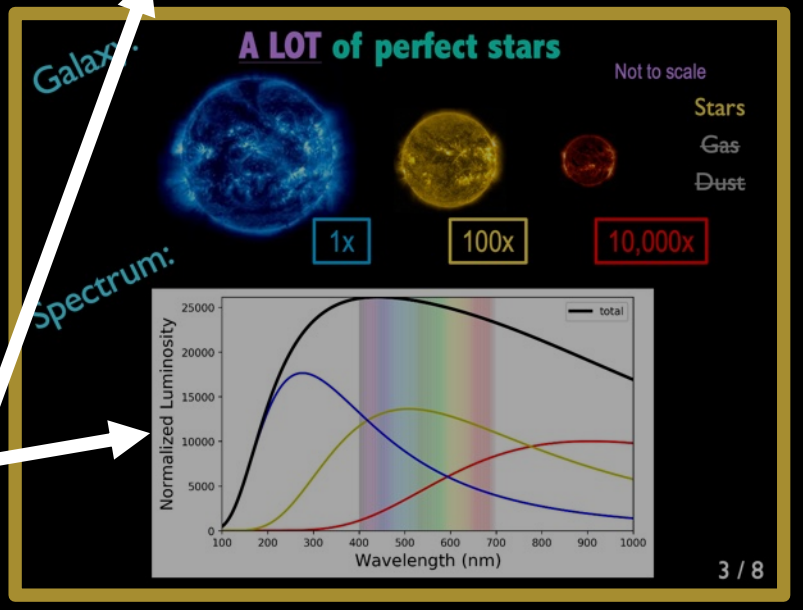
Learning Goal (for students):

Q: Can you explain
the different features
of a galaxy spectrum?

Inquiry-based learning: *Raising Questions*







Q: Why does a galaxy spectrum look like above?

A: Let students figure it out!

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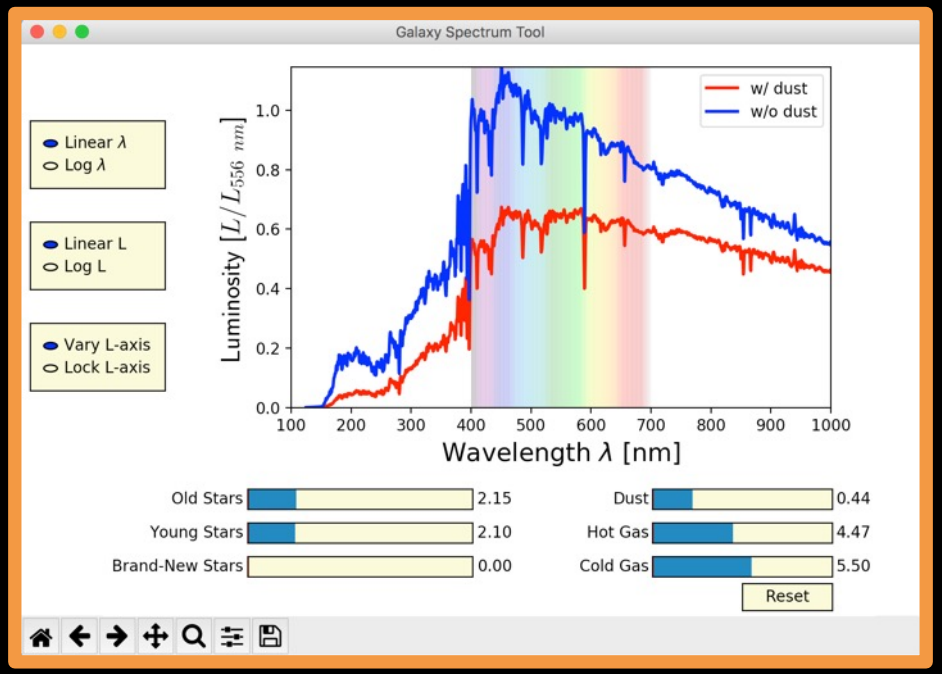
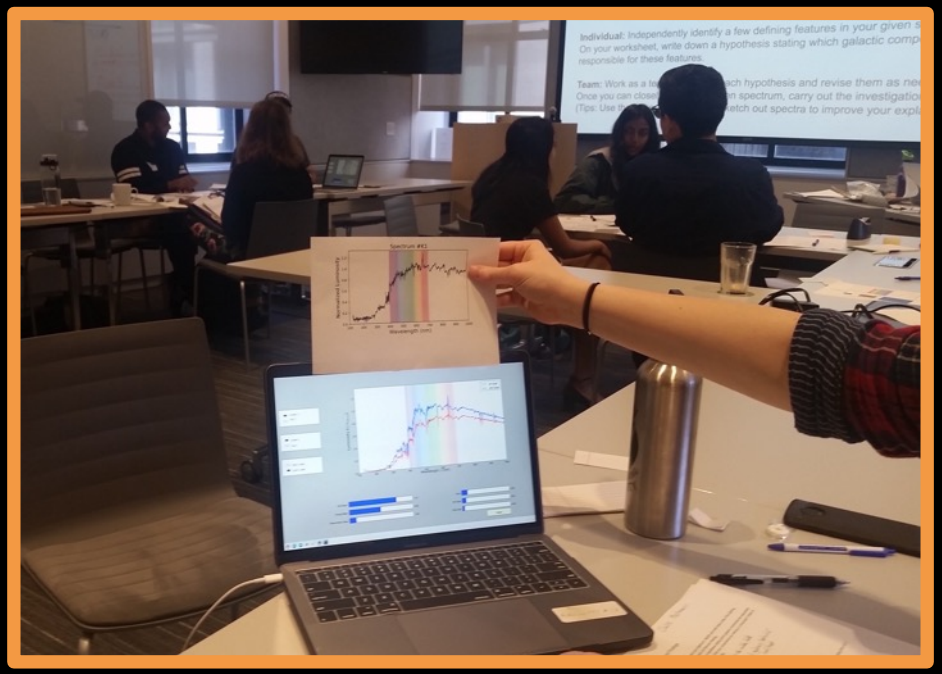
(1) Teach only the basics first!

(2) Provide simple examples to motivate questions.

Activity by Kate Storey-Fisher, Paul McNulty, and Michael Hammer (from ISEE PDP)

Inquiry-based learning: *Group Investigations*





(1) Teach only the basics first!

(2) Provide simple examples to motivate questions.

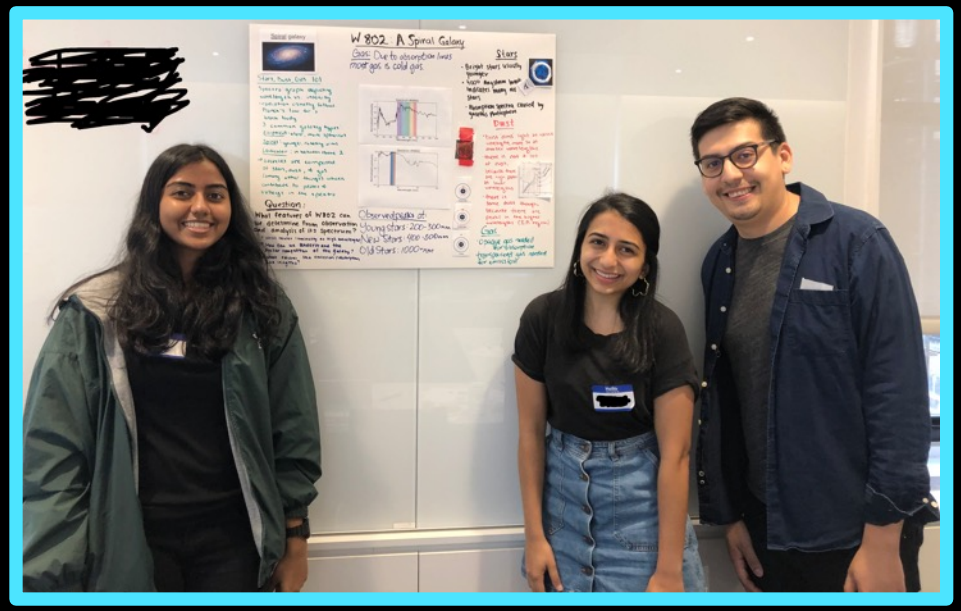
(3) Have them work together in groups to answer their questions.

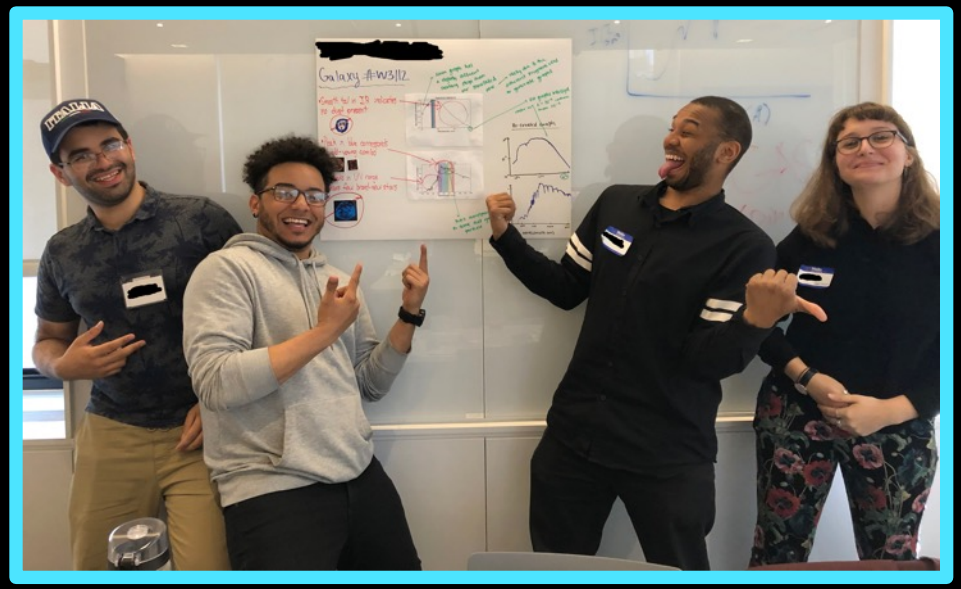
(4) Provide a means for students to investigate what they want to learn.

(5) Inter-mix groups for discussion so different groups can help each other.

Activity by Kate Storey-Fisher, Paul McNulty, and Michael Hammer (from ISEE PDP)

Inquiry-based learning: *Peer Presentations*





(1) Teach only the basics first!
(2) Provide simple examples to motivate questions.
(3) Have them work together in groups to answer their questions.
(4) Provide a means for students to investigate what they want to learn.
(5) Inter-mix groups for discussion so different groups can help each other.
(6) Have them make posters to present what they learned to each other and the instructors.
(7) Provide opportunity for them to receive recognition from peers.

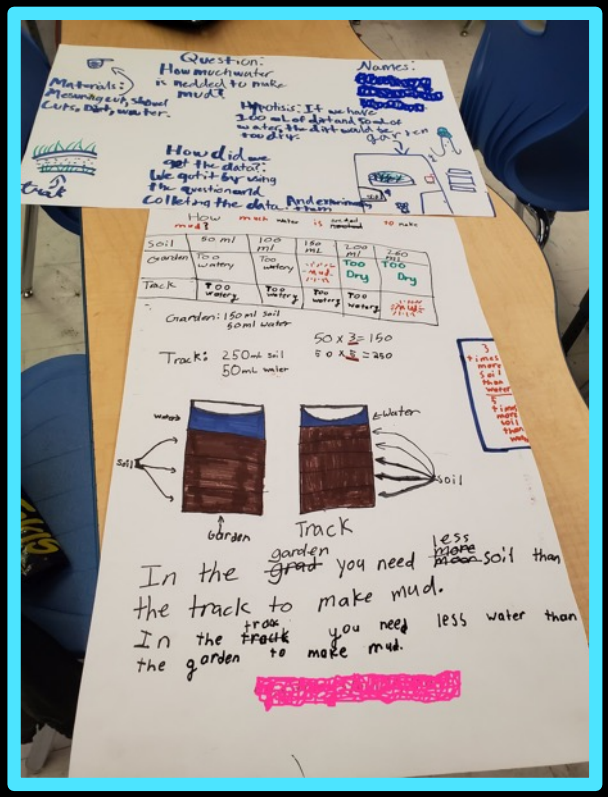
Activity by Kate Storey-Fisher, Paul McNulty, and Michael Hammer (from ISEE PDP)

Another way to *Raise Questions*

Let students come up with their own topics! (by putting them in nature)

UA Sky School
Example
4th Grade Projects:

Q: What do ants eat?



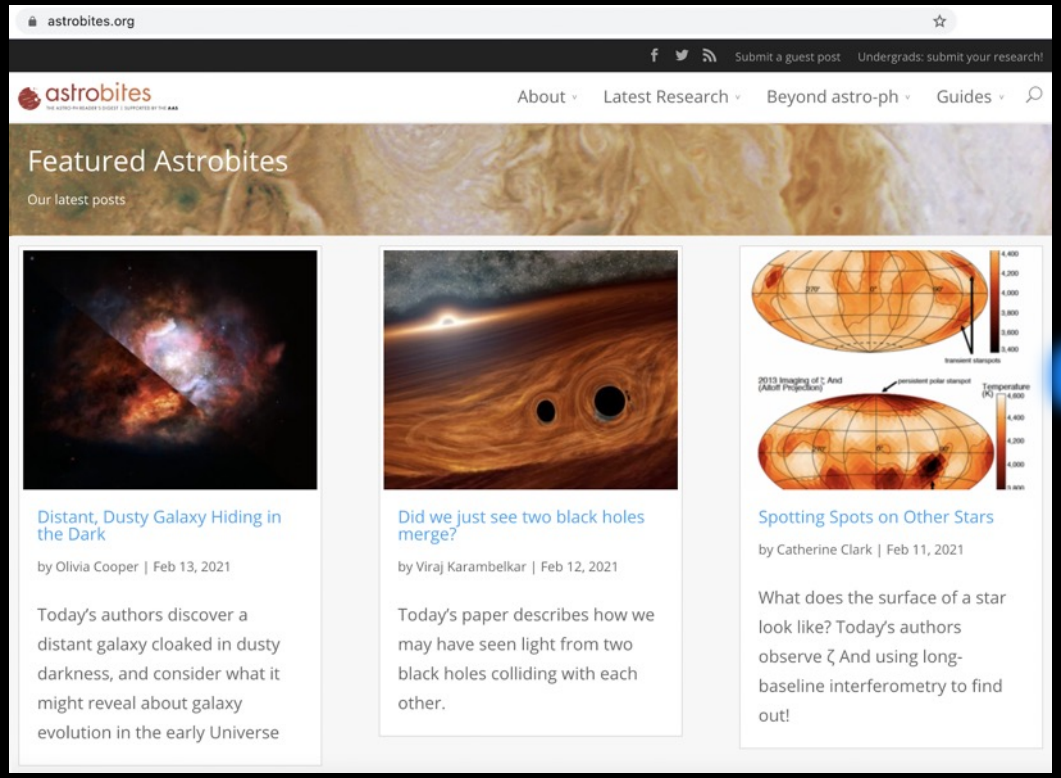
Q: How much water is needed to make mud?

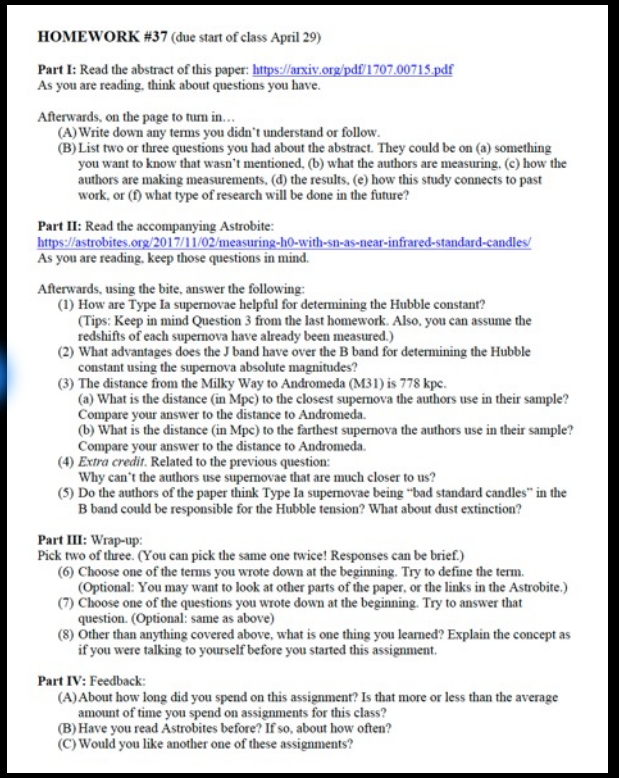
Another way to *Facilitate Investigations*

astrobites

THE ASTRO-PH READER'S DIGEST | SUPPORTED BY THE **AAS**

One short HW assignment





HOMEWORK #37 (due start of class April 29)

Part I: Read the abstract of this paper: https://arxiv.org/pdf/1707.00715.pdf
As you are reading, think about questions you have.

Afterwards, on the page to turn in…
(A) Write down any terms you didn't understand or follow.
(B) List two or three questions you had about the abstract. They could be on (a) something you want to know that wasn't mentioned, (b) what the authors are measuring, (c) how the authors are making measurements, (d) the results, (e) how this study connects to past work, or (f) what type of research will be done in the future?

Part II: Read the accompanying Astrobite:
https://astrobites.org/2017/11/02/measuring-h0-with-sn-as-near-infrared-standard-candles/
As you are reading, keep those questions in mind.

Afterwards, using the bite, answer the following:
(1) How are Type Ia supernovae helpful for determining the Hubble constant?
(Tips: Keep in mind Question 3 from the last homework. Also, you can assume the redshifts of each supernova have already been measured.)
(2) What advantages does the J band have over the B band for determining the Hubble constant using the supernova absolute magnitudes?
(3) The distance from the Milky Way to Andromeda (M31) is 778 kpc.
(a) What is the distance (in Mpc) to the closest supernova the authors use in their sample? Compare your answer to the distance to Andromeda.
(b) What is the distance (in Mpc) to the farthest supernova the authors use in their sample? Compare your answer to the distance to Andromeda.
(4) *Extra credit.* Related to the previous question:
Why can't the authors use supernovae that are much closer to us?
(5) Do the authors of the paper think Type Ia supernovae being "bad standard candles" in the B band could be responsible for the Hubble tension? What about dust extinction?

Part III: Wrap-up:
Pick two of three. (You can pick the same one twice! Responses can be brief.)
(6) Choose one of the terms you wrote down at the beginning. Try to define the term. (Optional: You may want to look at other parts of the paper, or the links in the Astrobite.)
(7) Choose one of the questions you wrote down at the beginning. Try to answer that question. (Optional: same as above)
(8) Other than anything covered above, what is one thing you learned? Explain the concept as if you were talking to yourself before you started this assignment.

Part IV: Feedback:
(A) About how long did you spend on this assignment? Is that more or less than the average amount of time you spend on assignments for this class?
(B) Have you read Astrobites before? If so, about how often?
(C) Would you like another one of these assignments?

Daily summaries of research papers written by graduate students (including me!)

…for undergrad classes

Another way to *Facilitate Investigations*

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(1) Read part of research paper. Write down unknown terms and questions.

(2) Read the Astrobite summarizing the paper.

(3) Using the bite, answer questions related to paper.

(4) Define their unknown terms. Answer their own questions.

(5) Give feedback on assignment.

Summary

The main idea behind ***inquiry-based learning*** is to have students *learn in the same way that scientists conduct research*.

Three Key Components:
(adapted from ISEE PDP)

Raising Questions
Group Investigations
Peer Presentations

In science teaching and science communication in general, keep in mind teaching not just *scientific knowledge*, but also ***scientific approach***.