THE UNIVERSITY OF UTAH

Bringing Argument-Driven Inquiry into IPLS labs

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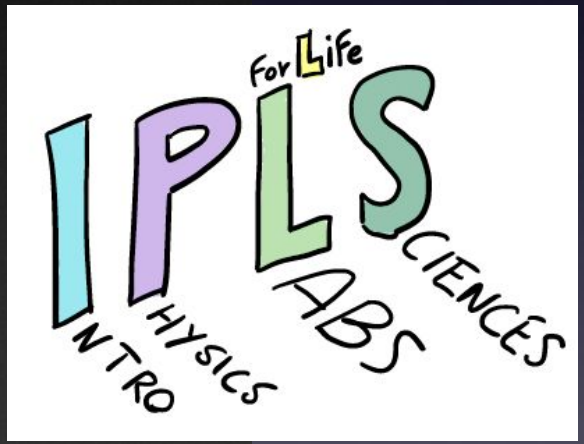


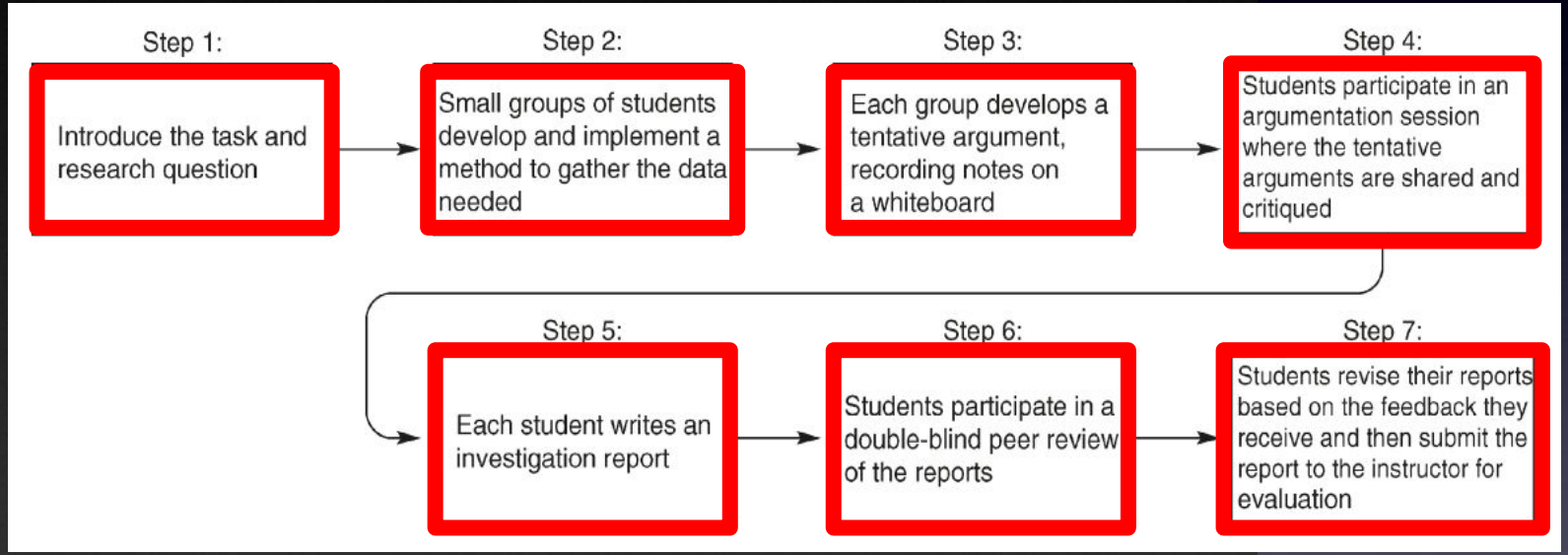
What is Argument-Driven Inquiry (ADI)

The ADI instructional model:

- Is a pedagogical tool initially designed for introductory undergraduate chemistry laboratory courses
- Focuses on a guided laboratory inquiry approach while incorporating **scientific argumentation** and peer review
- Has been adopted to undergraduate biology courses (Sampson & Gleim, 2009) and secondary education settings (Sampson, Grooms, & Walker, 2009)

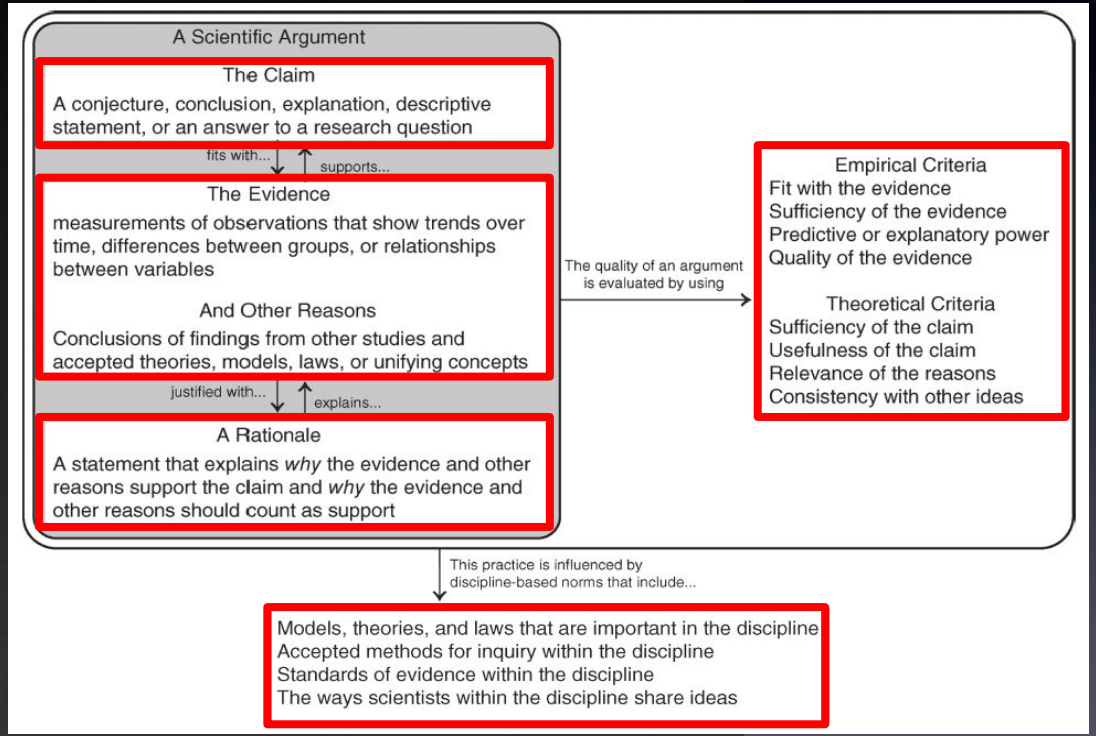
Argument-Driven Inquiry (ADI)

The seven steps of ADI:



ADI - Developing a Scientific Argument

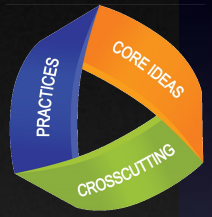
CER framework = backbone of ADI instructional model

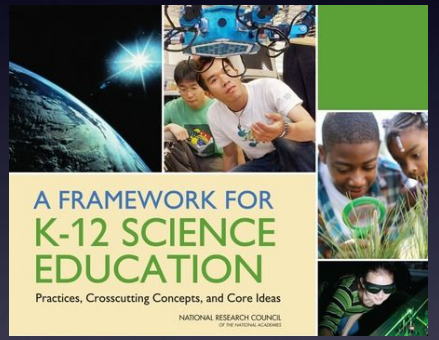


Intro Physics Labs for Life Sciences (IPL^{2}S)

PHYS 2015/2025: two-course (algebra-based) introductory lab sequence

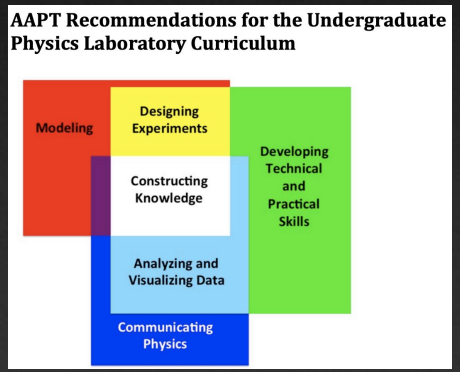
- About 300 students per semester - mostly life/health-science majors
- Independent from lecture course
- Prior to Spring 2018, covered traditional Mechanics/E&M topics using a traditional, prescriptive approach





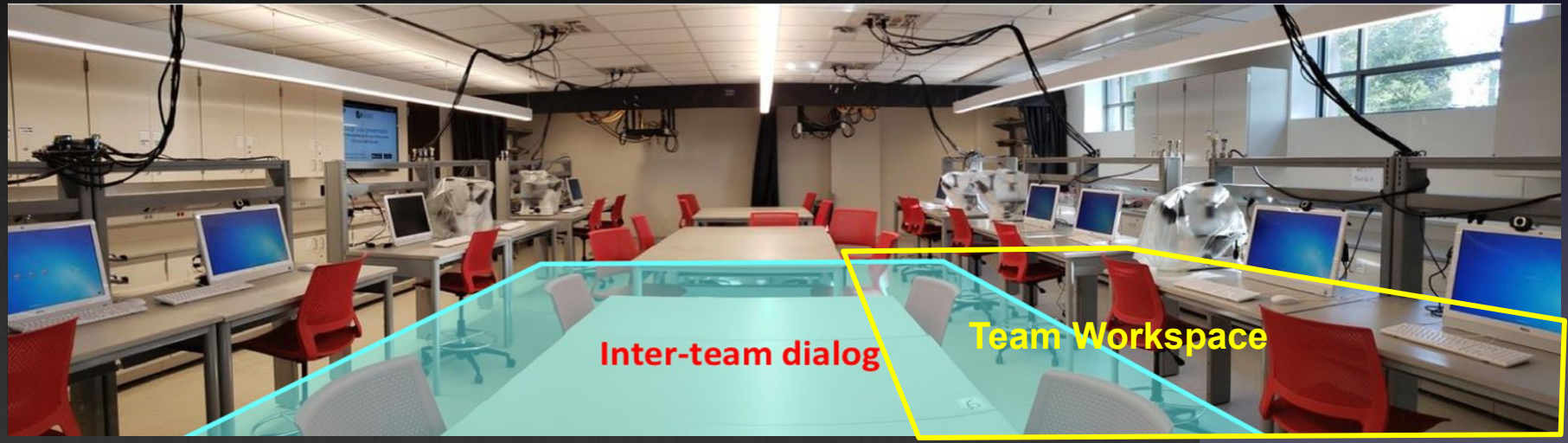
Motivations and inspirations:

- Emphasize scientific practices
  - Utilize PER/DBER research
- Content designed for Life Science majors
  - Utilize IPLS research
- Incorporate 3-dimensional learning
  - Utilize K-12 frameworks/standards



Intro Physics Labs for Life Sciences (IPL^{2}S)

PHYS 2015	**Lab 1:** Biological Kinematics (2 weeks)	**Lab 2:** Macroscopic Fluid Dynamics (3 weeks)	**Lab 3:** Brownian Motion & Diffusion (3 weeks)	**Lab 4:** Molecular Motors (3 weeks)
PHYS 2025	**Lab 5:** Hemodynamics (2 weeks)	**Lab 6:** Electrophoresis Up Close (3 weeks)	**Lab 7:** Spectroscopy &Fluorescence (3 weeks)	**Lab 8:** Axonal Signal Transmission (3 weeks)



Why bring in ADI?

Instructors recognized the need for:

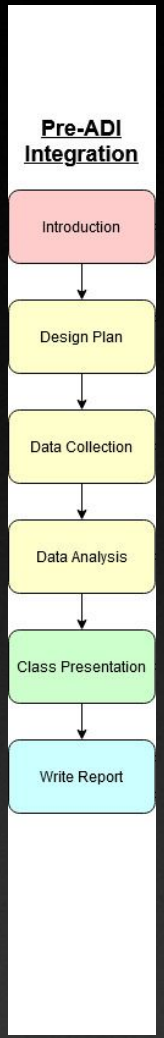
- Pedagogical methods to enhance students' development and communication of rigorous scientific arguments
- A more structured, instructional scaffolding to enhance course sustainability
- A shift in instructional strategies to more effectively promote scientific practices in a 3-dimensional learning setting

ADI:

- Maps well onto inquiry-based laboratory environments
- Aligns with scientific practices

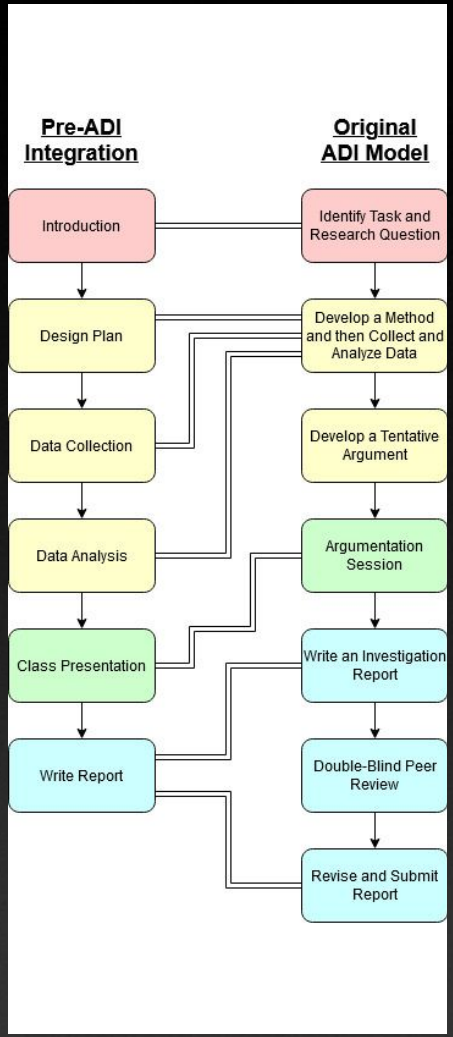
Adapting ADI to IPL^{2}S

- **Reviewed ADI literature, current course structure, and course objectives and goals**



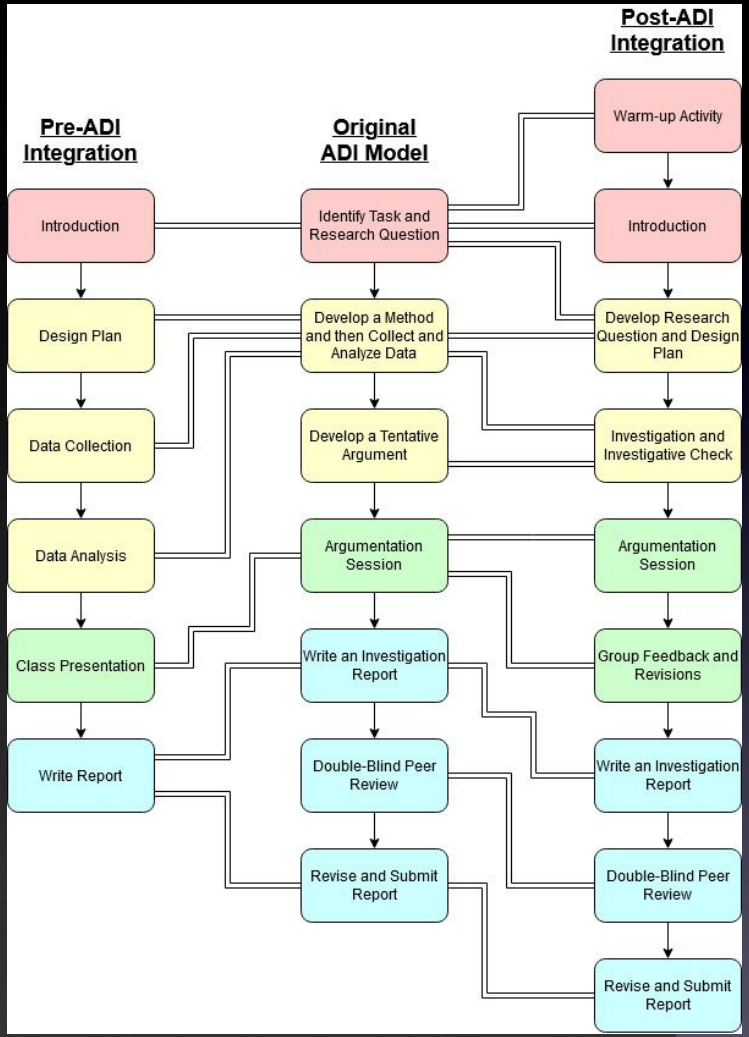
Adapting ADI to IPL^{2}S

- Reviewed ADI literature, reviewed current course structure, and identified course objectives and goals
- **Identified commonalities between original course structure and ADI model**



Adapting ADI to IPL^{2}S

- Reviewed ADI literature, reviewed current course structure, and identified course objectives and goals
- Identified commonalities between original course structure and ADI model
- **Consulted with instructional leadership, reviewed and updated course learning outcomes, and developed modified ADI instructional model for our course**



ADI in IPL^{2}S

IPL^{2}S Modified ADI Stage	Description
Warm-up Activity	Activity-based introduction to scientific concepts and experimental techniques.
Introduction	Teaching assistants (TA) gives a brief overview of the experiment and supplementary information.
Development of Research Question and Design Plan	Student groups develop a research question and plan their experiment.
Investigation	Groups collect and analyze data to complete their experiments and answer their Research Question.
Investigative Check	Groups present their scientific arguments and results to a TA or LA for constructive feedback.
Argumentation Session	Groups present their scientific argument and results to members of other groups.
Group Feedback and Revisions	Groups reconvene and discuss received feedback to make revisions.
Drafting of Lab Report	Students individually draft their lab reports in class. Students complete their reports at home after Peer Review.
Double-Blind Peer Review	Students participate in a peer-to-peer double-blind peer review process, providing (receiving) constructive feedback to (from) peers.

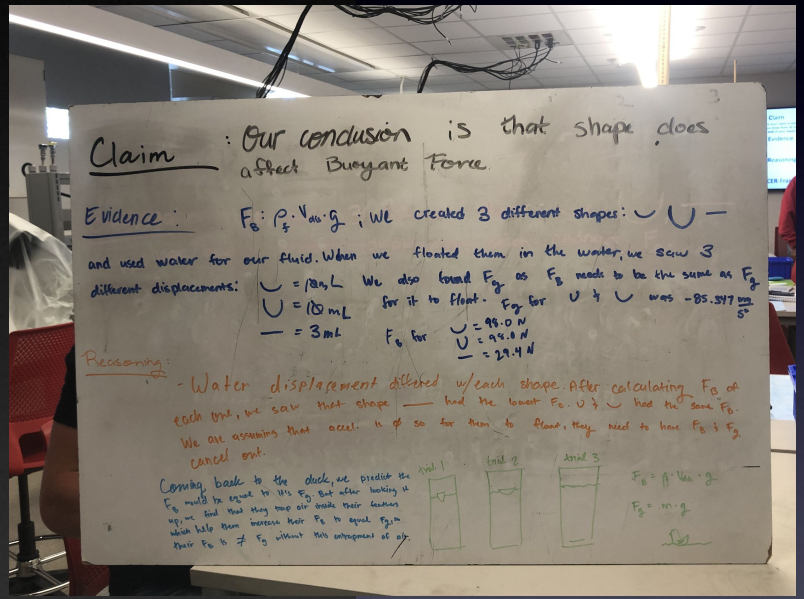
Outcomes of ADI Integration

- **Enhanced student development of scientific arguments**
- **Aided in the shift to online instruction** while maintaining course learning outcomes
- **Provided pedagogical consistency** in a course with rotating instructional leadership

ADI and Student-Generated Scientific Arguments

Pre-ADI implementation:

- **Students generated basic experimental claims not backed by evidence, without extensive scientific reasoning**



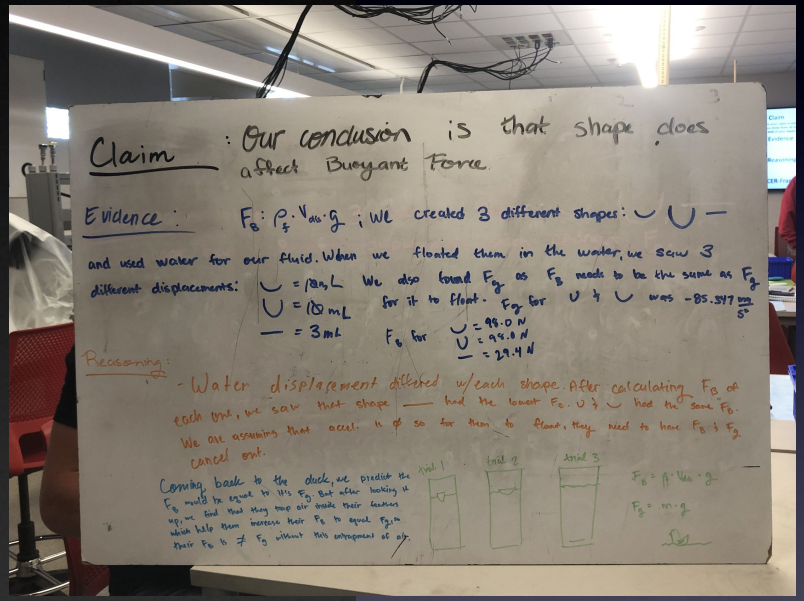
ADI and Student-Generated Scientific Arguments

Pre-ADI implementation:

- Students generated basic experimental claims not backed by evidence, without extensive scientific reasoning

Post-ADI implementation:

- **Students make claims based on evidence and generated scientific reasoning with the evidence to sensemake with external phenomena.**
- **Students anticipate potential claims (i.e., hypothesizing) and experimental extrapolations when first developing a research question and a design plan.**



ADI and Student-Generated Scientific Arguments

Pre-ADI implementation:

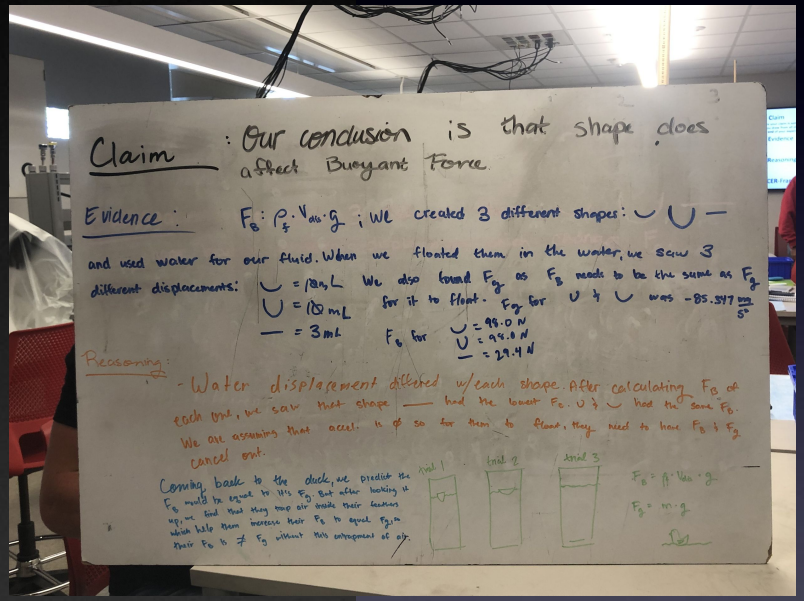
- Students generated basic experimental claims not backed by evidence, without extensive scientific reasoning

Post-ADI implementation:

- Students make claims based on evidence and generated scientific reasoning with the evidence to sensemake with external phenomena.
- Students anticipate potential claims (i.e., hypothesizing) and experimental extrapolations when first developing a research question and a design plan.

Continuing challenges:

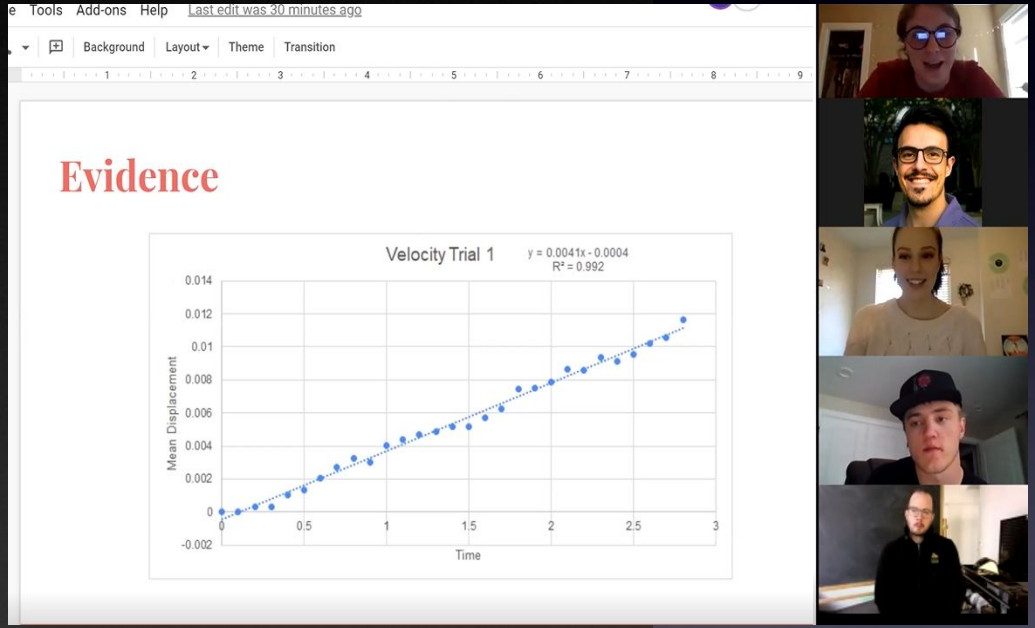
- **Students sometimes make trivial claims and research questions that do not focus on the mechanisms at play of the systems/phenomena.**



ADI and the Shift to Remote/Hybrid Labs

ADI has benefited hybrid instruction by:

- Providing pedagogical structure while increasing student agency and accountability.
- Aiding in the maintaining of course learning outcomes when other courses have required shifting learning outcomes.



ADI and the Shift to Remote/Hybrid Labs

Hybrid Instruction with ADI model involves:

- **Synchronous remote introductory class periods with asynchronous pre- and post-class assignments/videos**

Instructor video describing student investigations, helping prepare students to develop research questions and design plans

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Hybrid Instruction with ADI model involves:

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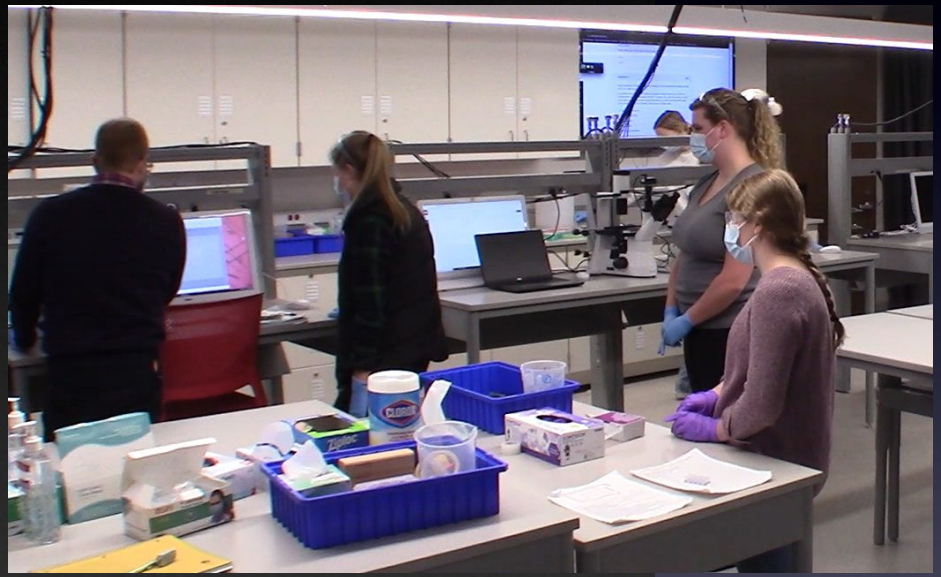
- **In-person data collection periods**

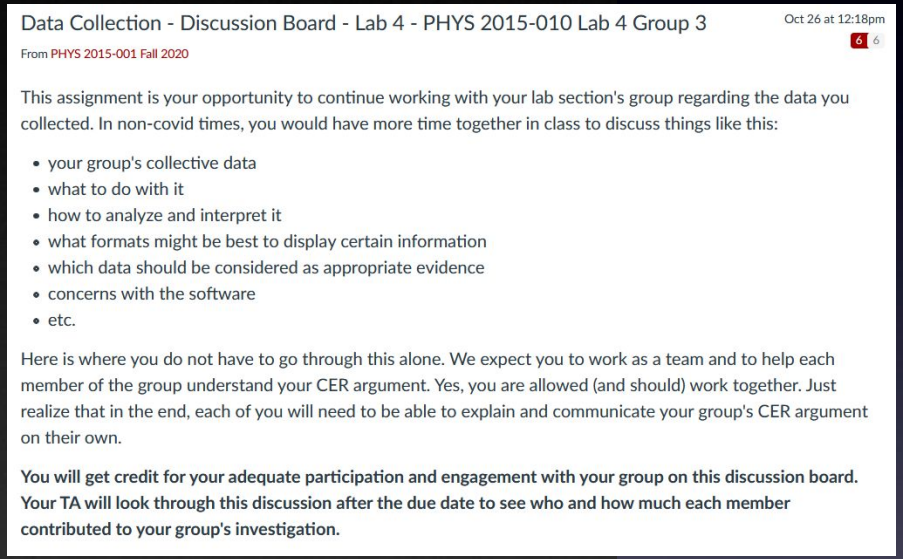


Students engaging in in-person data collection.

ADI and the Shift to Remote/Hybrid Labs

Hybrid Instruction with ADI model involves:

- Synchronous remote introductory class periods with asynchronous pre- and post-class assignments/videos
- In-person data collection periods
- **Asynchronous discussion boards and data analysis**



Data Collection - Discussion Board - Lab 4 - PHYS 2015-010 Lab 4 Group 3

Oct 26 at 12:18pm

6 6

From PHYS 2015-001 Fall 2020

This assignment is your opportunity to continue working with your lab section's group regarding the data you collected. In non-covid times, you would have more time together in class to discuss things like this:

- your group's collective data
- what to do with it
- how to analyze and interpret it
- what formats might be best to display certain information
- which data should be considered as appropriate evidence
- concerns with the software
- etc.

Here is where you do not have to go through this alone. We expect you to work as a team and to help each member of the group understand your CER argument. Yes, you are allowed (and should) work together. Just realize that in the end, each of you will need to be able to explain and communicate your group's CER argument on their own.

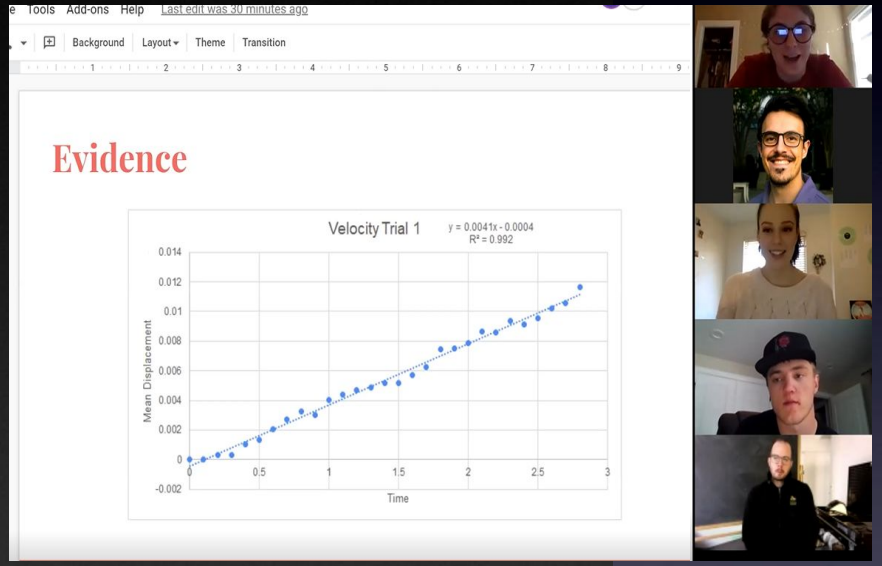
You will get credit for your adequate participation and engagement with your group on this discussion board. Your TA will look through this discussion after the due date to see who and how much each member contributed to your group's investigation.

Example discussion board students complete as part of their asynchronous analysis of experimental data

ADI and the Shift to Remote/Hybrid Labs

Hybrid Instruction with ADI model involves:

- Synchronous remote introductory class periods with asynchronous pre- and post-class assignments/videos
- In-person data collection periods
- Asynchronous discussion boards and data analysis
- **Synchronous remote presentation class period**



Students remotely presenting their scientific arguments via an Investigative Check to the TA.

ADI and a Rotating Instructional Team

Implementing a modified ADI model has increased course sustainability and allowed for a rotating (per semester) instructional team.

	Pre-IPLS Reform (pre-SP18)
Instructors	👨 (static)
Head TA	
TA	👩👨 (rotating)
LA	

ADI and a Rotating Instructional Team

Implementing a modified ADI model has increased course sustainability and allowed for a rotating (per semester) instructional team.

	Pre-IPLS Reform (pre-SP18)	Post-IPLS/Pre-ADI (SP18-SP19)
Instructors	👨 (static)	👩 (static)
Head TA		👨 (static)
TA	👩👨 (rotating)	👩👨 (rotating)
LA		👩👨 (rotating)

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Implementing a modified ADI model has increased course sustainability and allowed for a rotating (per semester) instructional team.

	Pre-IPLS Reform (pre-SP18)	Post-IPLS/Pre-ADI (SP18-SP19)	Post-ADI (F19-Present)
Instructors	👨 (static)	👩 (static)	👨👩👨👨 (rotating)
Head TA		👨 (static)	
TA	👩👨 (rotating)	👩👨 (rotating)	👩👨 (rotating)
LA		👩👨 (rotating)	👩👨 (rotating)

Conclusion

1. Argument-Driven Inquiry is an evidence-based instructional model which enhances student-developed scientific arguments and promotes authentic experimentation.
2. ADI can be successfully adapted into Physics lab courses, including IPLS labs.
3. Integrating ADI into Physics labs can:
   a. enhance student engagement in experimental design and argumentation
   b. aid in the shift to online instruction while maintaining course learning outcomes
   c. provide pedagogical consistency in courses with rotating instructional leadership

Thank you!

References

Grooms, J., Enderle, P., & Sampson, V. (2015). Coordinating scientific argumentation and the Next Generation Science Standards through argument driven inquiry. *Science Educator*, *24*(1), 45-50.

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