Introductory Physics Labs: A Tale of Two Transformations

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The manuscript describes a laboratory pedagogical approach known as Argument Driven Inquiry (ADI), which is adapted to an undergraduate physics lab. The authors do a good job describing the general flow of the lab (problem statement, pre-lab, proposal development, data collection, argumentation, and report). The approach places a heavy emphasis on developing scientific practices and ADI centers those practices around the argumentation cycle. The presentation of Argument Driven Inquiry to the TPT audience is beneficial because the technique is already promoted for grades 3-12 and NSTA publishes a couple of books for high school physics labs. The ADI approach has been used at the college level, with several publications related to Introductory Chemistry. In short, the method is highly relevant to the TPT readership who may be more familiar with other approaches like modeling instruction, but less so with ADI.

The authors also discuss a second adaptation to online and remote instruction, and implemented the ADI cycle. The discussion of online implementation of ADI was encouraging to me as an instructor because many of the critical elements of good lab instruction were still feasible, though challenging to implement.

The manuscript is well-written and easy to follow. Because the paper covers an entire lab transformation, it doesn't get much into the details of any one lab, but describes well the general flow of a typical lab investigation. Because the ADI cycle is described in both in-person and online environments, it gives some sense how the cycle can be adapted to various contexts rather than being a rigid technique that only works in a particular setting. Enough detail was provided to help me envision what it would be like to transform my own lab courses using ADI in a COVID environment.

The authors were careful to implement their approach using what I would consider standard resources for higher education: WebEx, LMS, free software tools, such as ImageJ and Tracker, and low-cost take-home kits. Again this suggests their approach would be adaptable in other contexts. The supplementary materials provided substantial additional detail for implementation with an overview of the lab topics and the equipment lists for take-home kits for Physics 1 and 2.

In terms of more detailed questions:

1. Could the authors devote a couple of sentences comparing ADI with Modeling Instruction? Both employ a specific learning cycle. Both involve whiteboarding and peer feedback. Both involve argumentation based on evidence, though Modeling Instruction addresses models explicitly as well. What are their primary differences?
2. In the proposal/data-collection phase in the online implementation, it describes how the authors used their prior experience to prepare online data sets aligned with common proposals. This was probably the most challenging part because it required familiarity with prior years' students. Can you clarify how many different data sets did you produced in alignment with proposals for each lab? Even something like "between 2 and 5 (median 3) data sets were produced for each lab in alignment with common proposals". Also, generally regarding the proposal phase it is unclear how different proposals could be and yet still be approved by the

GTA. How much does the GTA force the proposals into the same form? Would you permit a proposal that was reasonable, but has some flaw that is obvious once the data is collected?

3. Regarding the fully-online labs for Fall 2020, it would be nice to have a few more details about how the image analysis, motion tracking, and kits were used. Did some labs use the kits and other labs used analysis of provided images and videos? Or did students take their own images and videos to analyze? What fraction of labs required image/video analysis or what fraction used the labs. Some of these details could be added within existing sentences without adding much length.
4. For the Survey results discussed on the bottom of page 7, top of 8, can you clarify if those results only pertain to Spring 2020, or also to Fall 2020? For instance, is student access to a computer better in Fall 2020 or still are 8% of students struggling with access? Did you notice fewer non-participating students in the synchronous groups in Fall than in Spring?