Large TLEF Project – Final Report

Report Completion Date: (2017/09/01)

1. PROJECT OVERVIEW

1.1. General Information

Project Title:	**A "flipped" approach to large-scale first-year physics labs**		
Principal Investigator:	**Georg W Rieger**		
Report Submitted By:	**Georg W Rieger**		
Project Initiation Date:	**Sep 01 2014**	**Project Completion Date:**	**Mar 31 2016**

1.2. Project Summary

1.3. Team Members – *(Please fill in the following table and include **students**, undergraduate or graduate, who participated in your project).*

Name	Title/Affiliation	Responsibilities/Roles
Firas Moosvi	Graduate Student	Lab modifications/online implementation
Sophie Berkman	Graduate Student	Survey
Scott Vaele	Graduate Student	Implementation of online labs
Jeff Bale Damien Quentin Jonathon Schultz-Beach	Graduate Students	Implementation of online labs, inter-rater reliability of grading tool.
(Team members, Michael Sitwell, and Jared Stang involved at initial stages.)	Graduate Students	(Previous survey and report. Findings used in this project.)

1.4. Student Impact – *Please fill in the following table with **past**, **current,** and **future** courses and sections (e.g. HIST 101, 002, 2017/2018, Sep) that have been/will be impacted by your project, including any courses not included in your original proposal (you may adapt this section to the context of your project as necessary).*

Course	Section	Academic Year	Term (Summer/Fall/Winter)
PHYS 100	99C	2014W	Winter
PHYS 100	99C	2015W	Winter
PHYS 100	101, 102, 103, 99C	2016W	Fall, Winter
PHYS 100	98A	2017S	Summer
PHYS 100	101,102,103	2017W	Fall
PHYS 100	101, 102, 103, 98A	Foreseeable future	Fall/Summer

2. PRODUCTS & ACHIEVEMENTS

2.1. Products and Achievements – *Please **update** project products and achievements as necessary. Indicate the current location of such products and provide an URL if applicable.*

Product(s)/Achievement(s):	Location:
Modified labs for online use.	Connect/Piazza for 2014W, 2015W
Further modification for edX Edge	edX Edge

2.2. Item(s) Not Met – *Please list intended project products and achievements that were not attained and the reason(s) for this.*

Item(s) Not Met:	Reason:
Synchronous peer instruction using Blackboard Collaborate and LearningCatalytics.	Following a successful pilot study, it was clear that doing experiments at home with online support is feasible. Consequently, we adopted this format for all students. We dropped the idea of synchronous peer instruction as times are very hard to organize and enforce for so many students. Generally, synchronous instruction with students at home does not work well, as it restricts the flexibility of the course. Very few students log into synchronous office hours, for example. We are currently using asynchronous discussions on Piazza and the peer instruction tool on edX, to support the labs. This works fairly well.

3. PROJECT EVALUATION

3.1. Project Outcomes – *Please list the intended outcomes or benefits of the project for students, TAs and/or instructors.*

- General improvements of the labs guided by a previous survey and report.
- Labs online provide much more flexibility to students.
- Labs online open up the course to remote locations.
- Motivational and attitudinal benefits.

3.2. Findings – *Please describe the findings of your project evaluation effort: to what extent were intended project outcomes achieved or not achieved? You are encouraged to include both graphical representations of data as well as scenarios or quotes to represent key themes.*

1. Improved labs: This goal was achieved as we modified the content of some of the labs in response to students' views of the labs summarized in the report. We did not measure this goal directly as the delivery of the labs changed and we moved some content between labs.
2. We achieved this goal because we deliver all labs online now. Students in the distance section can complete the entire course at home, including the labs.
3. The online format did not compromise student learning. The final lab projects are at the same quality in the online labs as they were in the campus labs (see below).
4. The enrolment in the distance section has slowly increased since moving all labs online.
5. Teaching assistant hours dedicated to the labs in the face-to-face course are reduced by approximately 50% since adopting the online labs.
6. Focus groups revealed that doing labs at home does generally not have motivational or attitudinal benefits.

3.3. Data Collection and Evaluation Methods – *Please describe the data collection strategies used, how the data was analyzed, and perceived limitations.* ***Note: Please attach copies of data collection tools (e.g. surveys and interview protocols) and any additional data or other relevant items.***

a) Focus Groups:

Students' experiences with online resources in Physics 100: edX website, open textbook and lab

Focus group questions

1. What is your faculty (Science/Arts/etc.) and year of study?
2. Describe in general terms a few things you have learned in the labs.
3. Did you learn something in the labs that may be useful in other courses or outside of school?
4. Did you enjoy doing the labs at home?
5. Where do you see advantages and disadvantages of doing labs at home?
6. Do you think that you were doing Science in your the final project? Please elaborate.
7. Were you comfortable doing the labs at home or would you have preferred doing the labs in a teaching lab?
8. Is there anything else you want to tell us about your experience with the Physics 100 labs?

b) Evaluation of student learning: Final lab project.

A 24-question rubric was developed for grading the final projects. Teaching assistants would answer these questions as Yes (1/1) Partially (0.5/1) No (0/1)

The points shown are added up and divided by the total. A few of the questions may not be applicable, in which case the total is reduced by the corresponding questions. The equation expressing this is:

$$\boldsymbol{Mark = \frac{Points}{(24 - NA)} \times 100\%}$$

The 24 questions (grouped by category) are:

Clearly stated research question or clearly formulated goal

1. Is a research question formulated or a clear goal stated for the project?
2. Is motivation or general interest provided?
3. Is a hypothesis formulated or is there a prediction based on literature?

Clear description of the experiment

4. Is the experimental method described in such a way that anyone could repeat it?
5. Is it clear what equipment is used?

Sufficient data, quality of data

6. Is the data sufficient to answer the research question or goal?
7. Is a reasonable range covered by the data?
8. Is there an attempt to minimize uncertainty?
9. Is the experiment overall well designed (it has no significant shortcomings)?

Analysis of data, appropriate graphs

The inclusion of N/A is in case the rubric does not apply or if it is not important for the project. Any N/A will reduce the Total by -1, so that this question is not taken into account.

Yes (1/1) Partially (0.5/1) No (0/1) N/A

10. Is the data presented in an appropriate way?
11. Are graphs, histograms, and tables clearly labeled?
12. Are results extracted from the data and clearly presented?
13. Are advanced analysis methods used (fitting coefficients, polynomials, slopes, etc...).
14. Is the output of advanced analysis methods discussed meaningfully (slope of graph gives spring constant)?

Estimating uncertainty

The inclusion of N/A is in case the rubric does not apply or if it is not important for the project. Any N/A will reduce the Total by -1, so that this question is not taken into account.

Yes (1/1) Partially (0.5/1) No (0/1) N/A

15. Is there an attempt to estimate uncertainties?
16. Are standard deviations or standard errors used in a meaningful way?
17. Is there an attempt to use mean/STD/STE to discuss agreement?

Clear conclusions

Yes (1/1) Partially (0.5/1) No (0/1)

18. Does the summary refer back to the data?
19. Does it address the research question?
20. Are limitations of the project discussed?

TA Discretion Mark

Please note that we are NOT awarding TA discretion points for superior effort in formatting (i.e. No extra points if they use fancy clipart or a creative background for their report).

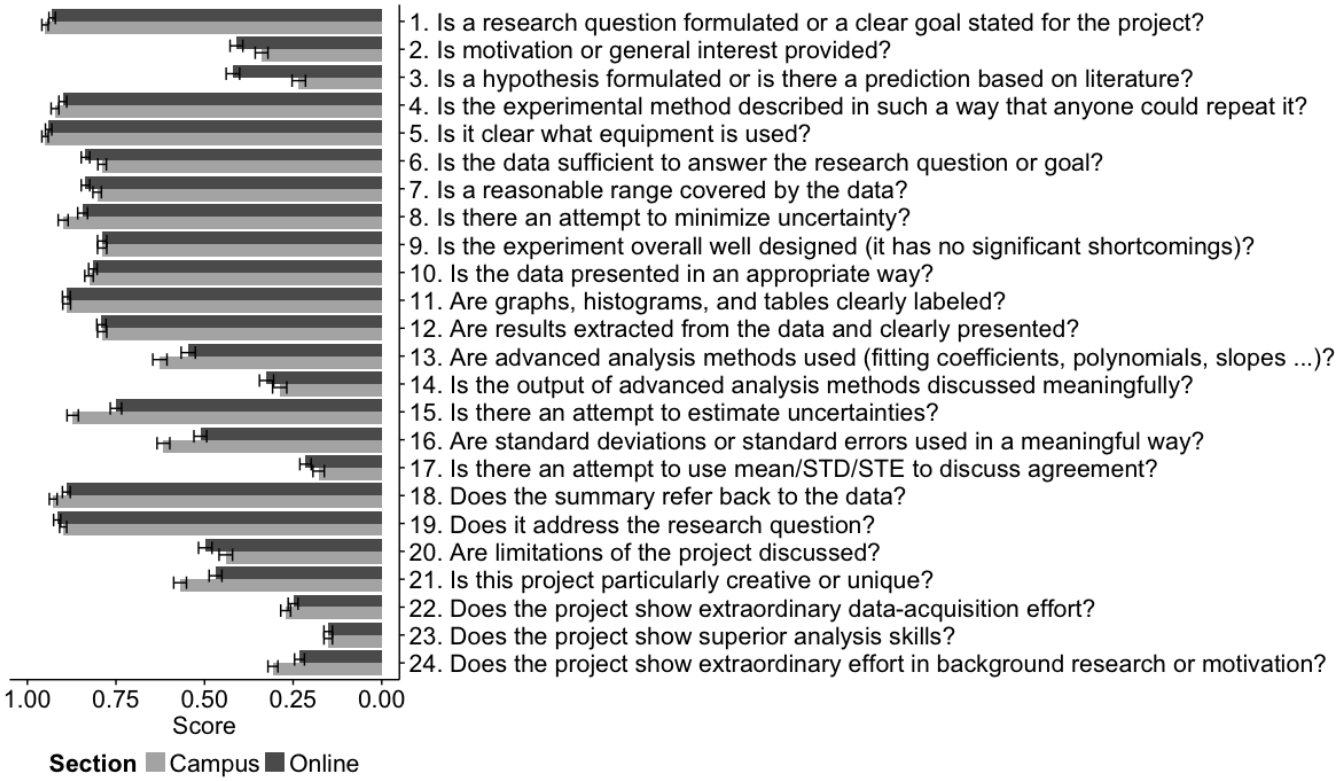
Yes (1/1) Partially (0.5/1) No (0/1)

21. Is this project particularly creative (i.e. do the students have a unique idea to collect data or analyze data or is the chosen topic outside the scope of Phys 100) ?
22. Does the project show extraordinary effort in terms of data acquisition (i.e. did they go above and beyond the call of duty to collect data) ?
23. Does the project show superior analysis skills (i.e. are the techniques used outside the Phys 100 eLabs)?
24. Does the project show extraordinary effort in terms of background research or motivation (i.e. did they learn and explain a concept in great detail that's not covered in Phys 100)?

The 24-question rubric was developed by the PI and converted into a web form by Firas Moosvi that allows easy access and use by the TAs. We found that marking with this rubric is straightforward and fairly quick. It also gives mostly consistent and relatively detailed results. The TA discretion mark is the most inconsistent rubric and requires a bit of training.

3.4. Dissemination – *Please provide a list of **past** and **future** scholarly activities (e.g. publications, presentations, invited talks, etc.) in which you or anyone from your team have or intend to disseminate the outcomes of this project.*

We have an almost finished draft of a manuscript that describes the online labs. One of our main results is that learning was not compromised by moving the labs online. This is shown in a graph that compares final project results that were submitted by students doing the online labs and by students that did the face-to-face labs the year before:



The graph and the focus group results are discussed in the manuscript. We plan to submit it to The International Review of Research in Open and Distributed Learning (IRRODL, http://www.irrodl.org/index.php/irrodl).

Our manuscript also discusses students' responses to our focus group. It is fair to say that we did not achieve our objective: students generally do not think of themselves as scientists when performing experiments at home, not even during the final project. Even though they practice and use scientific skills, students think of their projects as too simple and unsophisticated for it to be "real science". In their view real science requires sophisticated equipment.

4. TEACHING PRACTICES – *Please indicate if **your** teaching practices or those of **others** have changed as a result of your project. If so, in what ways? Do you see these changes as sustainable over time? Why or why not?*

After a small pilot project showed the feasibility of doing the labs online, they were first adopted for the distance course and then also for the face-to-face course. This means that over 800 students per year are now doing the PHYS 100 labs online.

Compared to the previous campus labs, there was no change in content and students perform almost identical learning tasks and mostly the same experiments (three experiments had to be modified for use at home.)

The main difference is in student support. To quote from our manuscript:

"In the campus labs, students work in pairs and peer discussions are an important part of the inquiry-based learning that takes place. In the online labs, students usually work individually, but are given the option to work with a partner. The peer discussions of the campus labs are replaced with a series of multiple choice and short

answer questions in the online labs. These questions are strategically designed to first allow students to think, and then reveal the answer automatically one step at a time. Students can also request hints on the Piazza discussion forum (piazza.com) if they are having difficulties with a particular question. All intermediate steps of a lab are required and online teaching assistants check for completion. Technical support for the online labs is delivered using Piazza and instructional videos. The videos provide technical help and suggestions on how to perform the most difficult experiments at home. The videos are not immediately available; they are released only after students had a chance to engage with the task and submit initial ideas."

5. **PROJECT SUSTAINMENT** – *Please describe the sustainment strategy for the project components. How will this be sustained and potentially expanded (e.g. over the next five years). What challenges do you foresee for achieving the expected long-term impacts listed above?*

The project is already sustainable as it currently is – we actually made the PHYS 100 labs much more sustainable by saving 50% of teaching assistant time. Nevertheless, we are thinking about further changes, mostly in response to the results of our focus groups: the final project did not have a positive impact on the students' attitudes towards the labs. In addition, it is scheduled at the end of the term when a number of students experience significant stress.

Most of our teaching assistant hours in the online labs are dedicated to supporting the final lab project. We are therefore exploring ways to replace the final project with other learning tasks that support our emphasis on understanding experimental data. We may also introduce an online lab test. We plan to keep all other online labs and their respective at-home experiments.

Replacing the final project would allow us a further reduction of teaching assistant hours, which could be used otherwise in the face-to-face course, for example for more office hours. It would also make the distance section scalable to a much larger enrolment (which is currently at 115 students).