TLEF Project – Final Report

Report Completion Date: (2022/03/01)

1. PROJECT OVERVIEW

1.1. General Information

Project Title:	Engineering Physics development of Resource-effective Apprenticeship Learning		
Principal Investigator:	Andre Marziali		
Report Submitted By:	Andre Marziali		
Project Initiation Date:	Apr 1, 2019	**Project Completion Date:**	Mar 31, 2022
Project Type:	☒ Large Transformation ☐ Small Innovation ☐ Flexible Learning ☐ Other: [please specify]		

1.2. Project Focus Areas – *Please select all the areas that describe your project.*

☒ Resource development (e.g. learning materials, media)

☒ Infrastructure development (e.g. management tools, repositories, learning spaces)

☒ Pedagogies for student learning and/or engagement (e.g. active learning)

☐ Innovative assessments (e.g. two-stage exams, student peer-assessment)

☐ Teaching roles and training (e.g. teaching practice development, TA roles)

☒ Curriculum (e.g. program development/implementation, learning communities)

☐ Student experience outside the classroom (e.g. wellbeing, social inclusion)

☐ Experiential and work-integrated learning (e.g. co-op, community service learning)

☐ Indigenous-focused curricula and ways of knowing

☐ Diversity and inclusion in teaching and learning contexts

☒ Open educational resources

☐ Other: [please specify]

1.3. Final Project Summary

This project embodied and enabled our exploration of apprenticeship type learning at scale, within Engineering Physics. Through multiple existing project courses, and through one additional course, we expanded the role of project based, apprenticeship-like instruction within the program, while also adjusting to the demands of Covid, and leveraging resources generated for remote learning. In brief, we've experimented successfully with enabling students to pursue engineering projects outside of school through technical workshops that we provide online, while also shifting class time to more hands-on work and demonstrations. Even in software, we've found tremendous uptake from students for guided self-learning where the instructor points students to resources and mentors them through their application, rather than simply providing the material through lecturing.

Partly as a result of this project, Engineering Physics now has a coherent stream of courses – ENPH 259,253,353,459,479 that introduce the students to self-learning through projects, increasing the independence of the students and open-endedness of the projects as they progress through this series. The material we have developed and future material that we will develop is portable to other programs and faculties. We expect that as we collect this material into accessible repositories, it will form a lasting resource for applied science instruction within any faculty at UBC and possible even outside of UBC.

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

Name	Title/Affiliation	Responsibilities/Roles
Andre Marziali	Professor, PHAS; Director, Eng Phys	Project management, ENPH 253 development, Workshop development
Dylan Gunn	Director, Eng Phys Project Lab	Course instruction and development. Lab operations. Staff management and supervision
Miti Isbasescu	Software Engineer	Course and content development and instruction.
Bernhard Zender	Technical Support	Workshop development, course development support
Griffin Pierce	Student	ENPH 353 development
Gregory Reed	Student	ENPH 479 development

1.5. Courses Reached – *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 reached by your project, including 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)
ENPH 353	101, 201	2019	Winter
ENPH 253	941	2020	Summer
ENPH 353	101, 201	2020	Winter
ENPH 479	101	2020	Winter
ENPH 253	941	2021	Summer
ENPH 353	101, 201	2021	Winter
ENPH 459	001	2021	Winter
ENPH 479	101	2021	Winter
ENPH 253	941	2022 and beyond	Summer
ENPH 353	101, 201	2022 and beyond	Winter
ENPH 459	001	2022 and beyond	Winter
ENPH 479	101	2022 and beyond	Winter

2. OUTPUTS AND/OR PRODUCTS

2.1. *Please **list** project outputs and/or products (e.g. resources, infrastructure, new courses/programs). Indicate the current location of such products and provide a URL if applicable.*

Product(s)/Achievement(s):	Location:
ENPH 353 course content	https://projectlab.engphys.ubc.ca/enph-353/
ENPH 459/479 course content and revised structure	https://projectlab.engphys.ubc.ca/enph-459/
Project Lab Re-organization	Hennings 115
ENPH 253 course content	https://projectlab.engphys.ubc.ca/enph-253/
ENPH Workshops	https://projectlab.engphys.ubc.ca/workshops/
Soldering workshop	https://www.youtube.com/playlist?list=PLNJmVpWq3C_kJP4KxrzyOaIGJqoMxI2vP
CAD Workshop	https://www.youtube.com/playlist?list=PLfCQFn-5zQeamx4z2XY4er1pVen_XJd5a
Lasercutter Workshop	https://www.youtube.com/playlist?list=PLfCQFn-5zQeZwizYKJ4SH1w-P3TkE5dvL
Waterjet cutter workshop	https://www.youtube.com/playlist?list=PLfCQFn-5zQeY-e6ws0ie9YWhipC-PV0EW
Graduate attribute worksheet	Stored locally

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

Item(s) Not Met:	Reason:
ENPH 200,400 development	Replaced during COVID with workshop development
	and methods for online delivery of project work

3. PROJECT IMPACT

3.1. Project Impact Areas – *Please select all the areas where your project made an impact.*

☒ Student learning and knowledge

☒ Student engagement and attitudes

☐ Instructional team-teaching practice and satisfaction

☐ Student wellbeing, social inclusion

☐ Awareness and capacity around strategic areas (indigenous, equity and diversity)

☒ Unit operations and processes

☐ Other: [please specify]

3.2. What were you hoping to change or where were you hoping to see an impact with this project? – *Please describe the intended benefits of the project for students, TAs, instructors and/or community members.*

After much deliberation on graduate attributes and metrics, we've come to the conclusion that there is a single, very important attribute that the majority of our students are currently missing even as they graduate: The ability and natural tendency to apply physics intuition to understanding how systems and machines work, and to use that intuition in engineering design. This is akin to the students having an "Expert" level of understanding or "Expert attitudes". Many of us acquire this intuition in graduate work or in industry engineering work, through frequent mentoring, supervision, and project experience.

We believe the changes we have made and are making to the Eng Phys project content will help develop this intuition. We will be assessing this as part of our graduate attribute measurement process over the next few years, as students currently entering 2nd year reach our capstone courses.

3.3. Were these changes/impacts achieved? How do you know they occurred? – *How did you measure changes/impacts? (e.g. collected survey data, conducted focus groups/interviews, learning analytics, etc.) Describe what was learned from this process. You are encouraged to include copies of data collection tools (e.g. surveys and interview protocols) as well as graphical representations of data and/or scenarios or quotes to represent and illustrate key themes.*

We will be measuring the impact of our program changes to the students' expert intuition through the graduate attribute system over the next few years. Since many of the changes are recent, we suspect we'll only see significant improvement after the first cohort of students that has recently entered the program reaches the capstone course. Ultimately, the student intuition and attitudes in ENPH 479 will determine whether we have achieved this impact.

3.4. Dissemination – *Please provide a list of **past** and **upcoming** scholarly activities (e.g. publications, presentations, invited talks, etc.) in which you or anyone from your team have shared information regarding this project. Be sure to include author names, presentation title, date, and presentation forum (e.g., journal, conference name, event).*

None. We will (and are) disseminating the workshop content through our website. We will make this more formal over time so that it is easier for others to access it.

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?*

Yes, while still early in some project courses, we are altering our teaching practices to reflect the success of the ENPH 353 model, which makes heavy use of online material, including that provided by others, for knowledge transfer, leaving more class time to direct mentoring. For ENPH 253, this will translate to substantially more 1:1 or 1:few instruction in class on engineering design and understanding.

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?*

Alongside the TLEF funding, Eng Phys has been fundraising aggressively to help provide additional funding to continue and expand these changes in our teaching. We now have financial support for the Project Lab through an endowment funded by some of our alumni, and through multiple industry contributors. We are hoping to expand the number of staff in the project lab in the near future to help support more content development and more direct mentoring of students.

In the meantime, we will continue to evolve the teaching methods developed in this project, and continue to add workshop content, eventually testing the latter with other departments as well. The Summer 2022 offering of ENPH 253 will be the first time the lectures will have been provided entirely through pre-recorded online material linked to at-home workshop and project tasks, and where the class time will be dedicated to engineering practice. Our experiences with this offering will guide development of all the project courses.