TLEF Project – Final Report

Report Completion Date: (2020/03/14)

1. PROJECT OVERVIEW

1.1. General Information

Project Title:	**Seeing Fast and Slow: Engaging undergraduates in science through slow motion video analysis**		
Principal Investigator:	V. Milner		
Report Submitted By:	V. Milner		
Project Initiation Date:	2018/05/01	**Project Completion Date:**	2019/08/31
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. Project Summary

Engaging undergraduates in active learning is critical for advancing their scientific literacy, which plays increasingly bigger role in modern society. Introductory Physics-101 is one of our best platforms to achieve this goal. Yet because it examines fast-speed phenomena which cannot be seen by the naked eye (e.g. acoustic vibrations), keeping the students engaged is challenging. We propose to use our newly acquired high-speed camera for in-class demonstrations of fast phenomena that are impossible to visualize and analyze otherwise. In-class recorded slow motion videos will also be used in labs and homework assignments. They will be incorporated in science methods courses at UBC Teacher Education to train future secondary science teachers on novel, previously inaccessible technologies. This innovative project will launch new collaborations between the Faculties of Science and Education and complement our recently completed successful TLEF-funded resource of K-12 videotaped science experiments used by hundreds of Teacher-Candidates and practicing teachers.

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
Marina Milner-Bolotin	Associate Professor	Co-PI
Oded Aminov	Graduate student/Work-Learn summer student	Developer
Walter Wasserman	Graduate student/ Work-Learn summer student	Developer

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)
Physics 101	103	2018/2019	W1

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:
Nine (9) physics demonstrations utilizing fast camera and slow-motion videos	Department of Physics and Astronomy, Department of Curriculum and Pedagogy

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:

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.*

Our objective was to engage students in large introductory physics courses, such as Physics-101 in active learning through using the technology of high-speed video recording to “slow down” phenomena which are too fast to be followed by the naked eye. We wanted to pique student curiosity about physics and its everyday life applications using slow motion videos, to turn a passive watching of YouTube movies into a collaborative in-class recording and experimentation. We were planning to design and test slow-motion educational videos in such a way as to record them in front of the live student audience during lectures, involving students in scientific inquiry. We anticipated to establish a collaboration between the Faculties of Science and Education on designing slow-motion educational resources and the use of advanced technology, promoting active learning at UBC.

3.3. Were these changes/impacts achieved? How do you know they occurred? – *What evaluation strategies were used? How was data collected and analyzed? 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.*

In the course of this project, we have designed and completed the following 9 demonstrations (concepts are outlined in brackets):

1. The falling cup with water (hydrostatic pressure);
2. The falling slinky (wave propagation);
3. Standing wave on a string (one-dimensional standing wave);
4. The vibrating Chladni plate (two-dimensional standing wave);
5. The vibrating Chinese bowl (three-dimensional standing wave);
6. The vibrating tuning fork (acoustic waves);
7. The shattering wine glass (resonance);
8. Interference in a popping soap film (thin-film interference);
9. Double-slit experiment with water waves (three-dimensional wave interference);

All nine of those demonstrations were implemented in Physics 101, 2018/2019 W1, and proved extremely useful for students as reflected by an overwhelming support of this teaching tool in student evaluations.

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.*

V. Milner has presented the results of this project at the Science Education Supper Series on Sep. 24, 2019.

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?*

See 3.3.

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?*

Both the PI and Co-PI are continuing to actively use the created physics demonstrations and the unique "Slow Motion Chamber" setup in teaching their classes (e.g. Phys 101) and in various outreach activities (e.g. UBC Math and Science Day).