TLEF Project – Final Report

Report Completion Date: (2019/09/30)

1. PROJECT OVERVIEW

1.1. General Information

Project Title:	Animated worked examples to support self-directed learning in Physics 100		
Principal Investigator:	Georg Rieger		
Report Submitted By:	Georg Rieger		
Project Initiation Date:	May, 2016	**Project Completion Date:**	Aug, 2019
Project Type:	☐ Large Transformation ☒ Small Innovation ☒ Flexible Learning ☒ Other: Open Education		

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

The overall goal of the project is to support student learning in PHYS 100 outside of class. The project was initially designed to use animated worked examples in support of students' learning from homework, based on research by Gladding et al. (PRST - PER 11, 010114, 2015) and the well-known worked example effect (A. Renkl "The Worked Examples Principle in Multimedia Learning" in The Cambridge Handbook of Multimedia Learning, ed. by R. Mayer, 2nd ed. 2014). In our second funding year, we extended the project to also use video examples as an illustration of our reading assignments, thus providing support to the students' initial exposure to a new topic. Accordingly, we have created two types of animated worked examples: relatively simple examples that are embedded into the reading part and more complex examples for the problem sets (homework). The video examples are now part of a website on edX.edge that combines all materials needed for PHYS 100. This resource is in the form of a complete online course that supports students in both, the distance education section and the face-to-face sections. In our final funding year, we evaluated the project and made some improvements to the videos and other course resources based on feedback from student surveys and focus groups. The project has an impact on approximately 800 – 900 students annually.

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
Georg Rieger	Instructor, Physics & Astronomy	PI
Stefan Reinsberg	Assoc. Professor, Physics & Astronomy	Co-applicants/supervisor
Maya Tovar	Sess. Lecturer, Physics & Astronomy	Co-applicant/supervisor
Christina Hendricks	Prof. of Teaching, Philosophy	Co-investigator
Electra Eleftheriadou	Post-doc, Physics & Astronomy	Focus groups
Raghav Aggarwal	Undergrad student, UBC	Research assistant, edX data
Kirsten Bale	Undergrad student, UBC	Video creator
Aldona Czajewska	Undergrad student, UBC	Video creator
Hayley Eng	Undergrad student, UBC	Video creator
Zimeng Li	Undergrad student, UBC	Video creator
Monica Luo	Undergrad student, UBC	Research assistant
Rochelle Maher	Undergrad student, UBC	Research assistant
Anita Mahinpei	Undergrad student, UBC	Video creator
Sam MacKinnon	Undergrad student, UBC	Video creator
Harsh Rajoria	Undergrad student, UBC	Research assistant, additional resources
Neall Struwig	Undergrad student, UBC	Video creator
Natalie Yung	Undergrad student, UBC	Video creator
May Zhao	Undergrad student, UBC	Research assistant, additional resources

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)
PHYS 100	All sections	2016 – present	Fall term (F2F)/ Summer term (distance ed)

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:
42 (mostly) interactive video examples	PHYS 100 course website on edX.edge

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:
We could not show a correlation between the use of video and increase in student learning. We expected only a small effect if any, but could not do the study to the extend we wanted. (Small-scale follow-up research is still ongoing.) We did not administer the CLASS survey in 2018W, as planned.	Technical difficulties limit the number videos that can be used for our study. Only youtube videos show up as videos in edX clickstream data. Videos in iFrames on Kaltura or elsewhere are not identifiable. The course instructors were worried about administering too many surveys and prioritized their own surveys.

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

☐ Student wellbeing, social inclusion

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

☐ Unit operations and processes

☒ Other: Research on open textbooks.

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.*

The main objective of the project is to provide support for students' learning outside of the classroom. In particular self-directed learning from homework and pre-class reading assignments is targeted. As the worked examples demonstrate correct, expert-like problem solving, we expect an improvement in problem-solving skills. Many students do not systematically use representations such as diagrams, graphs, or pictures when solving problems. The animated video examples consistently emphasize the use of these tools. We hope that students will over time adopt a systematic use of representations and become better problem-solvers.

Adding worked examples to the homework will also save students valuable time. They don't need to search for answers to homework questions or explanations. Relevant worked examples are directly linked to difficult homework problem questions. The worked examples are also a valuable tool for exam preparation.

The project also had an impact on project participants since it gave young undergraduate students a chance to get a work-learn job and to gain experience in project work. Since they had to think deeply about the best way to present a problem-solution, the project has deepen their physics knowledge. They also engaged with technologies, such as video production, editing and integrating the videos in other websites (youtube, H5P). I have already provided references for seven of my former work-learn students.

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.*

We believe that this project was quite successful. Although a direct link between use of video and student performance on test could not be demonstrated, our student survey and focus groups demonstrated that students find the videos generally helpful and beneficial. In more detail our results showed

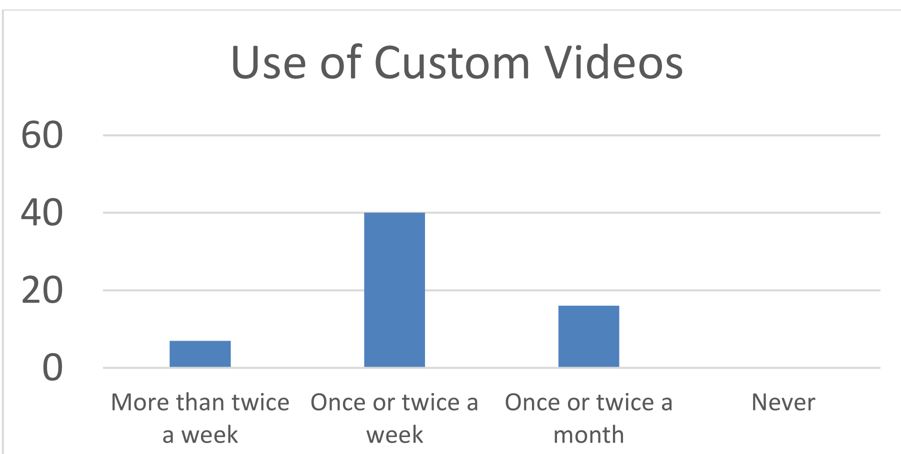
- How often the students use our videos
- For which purposes the students use the videos
- Which features they find valuable
- What students thought could be improved

Based on our results from surveys and focus groups, we have made further improvements to the course at the end of the third funding period. For some of the videos we created new voiceovers, made them shorter and embedded additional quiz questions. These improvements followed from student suggestions in surveys and focus groups. Other improvements were made to the test bank, such as providing hints in online tests and expanding our test bank with new questions.

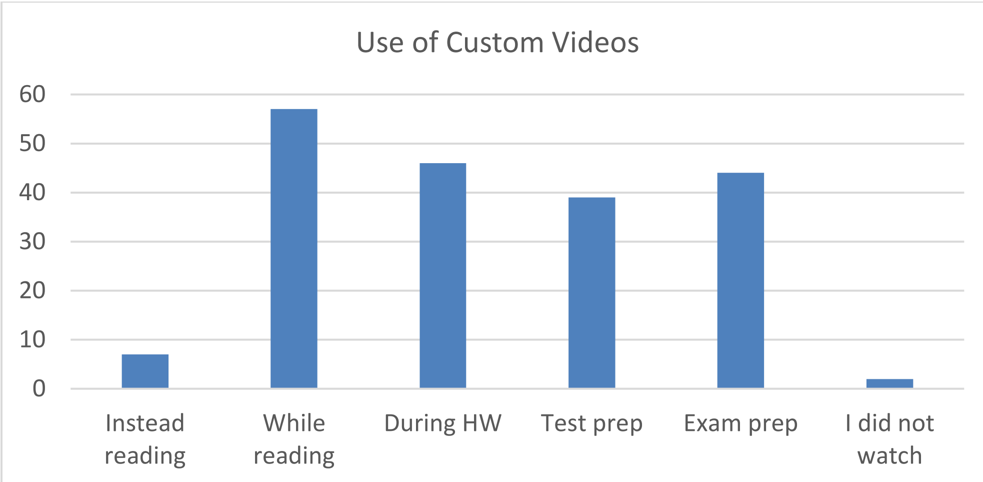
Another benefit that was initially not targeted was the increased customization and coherence of the course materials. Our research shows that students rate the customization of the course materials as important as the fact that our resources are free (Hendricks, Reinsberg and Rieger, 2017). Overall the organization and presentation of the PHYS 100 course materials on the edX.edge website is highly regarded by our students.

Below we show the relevant data that we also presented during the TLEF session of Celebrate Learning 2019.

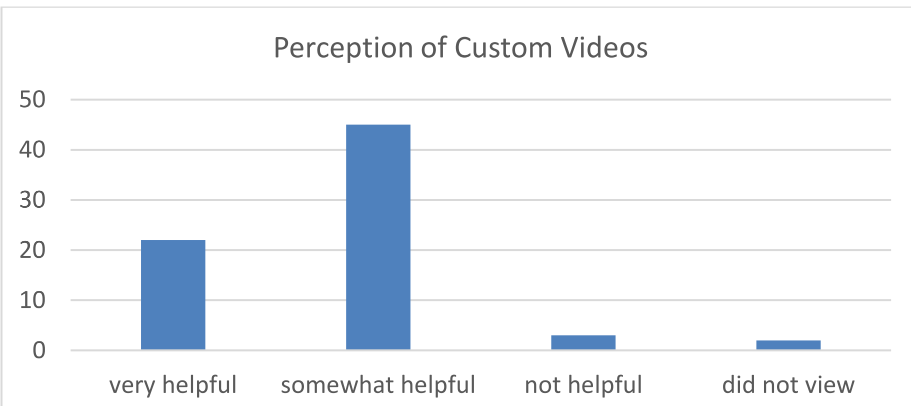
A) How often are students viewing a PHYS 100 video? (Number of respondents)



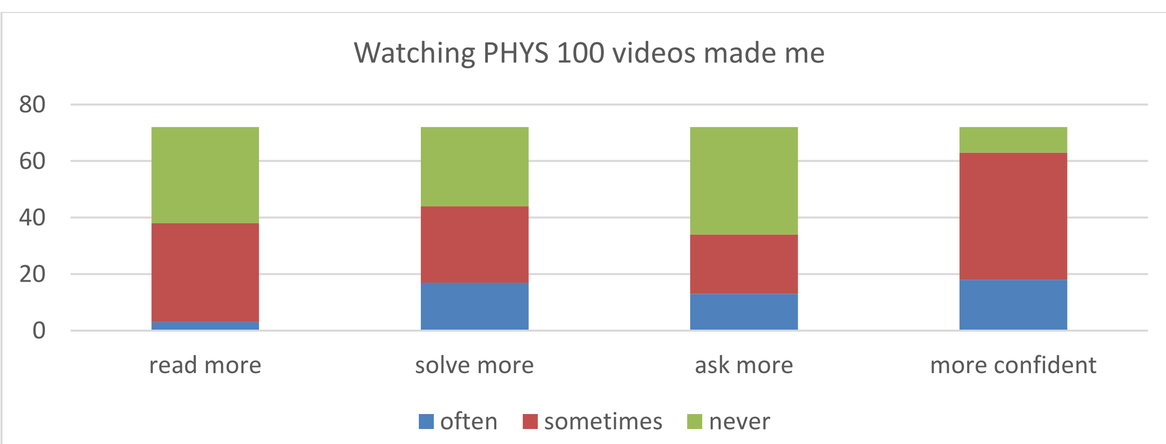
B) For what purpose do they use a PHYS 100 video? (Number of respondents)



C) Do student perceive PHYS 100 videos as helpful?



D) We asked students whether the videos had other consequences.



E) Positive comments from surveys (number of comments)

16	step-by-step explanations
16	helpful explanations (general)
12	worked-out examples helpful
8	increase conceptual or procedural understanding
6	visual representation helpful
6	transferable to other questions, problems
3	listening is good
2	always available
2	interesting real-world connections
2	help solve problems
2	relevant to exams
1	informative

F) Negative comments from surveys (number of comments)

8	too long or too slow
6	accent, monotone, hard to understand
2	"outdated" look
2	boring
1	not enough detail
1	notetaking is hard from videos

1	repetitive
1	some examples too complicated

G) Further comments from focus groups

Most comments emphasized what was also expressed in the survey comments listed above. One additional finding from our focus groups is that all participants prefer videos with embedded questions over videos that have no questions embedded.

Ongoing:

As briefly stated in section 2.2, we are still investigating the edX clickstream data for possible correlations between video use and performance on related test questions. For this purpose, the videos were rated in terms of their relevance to the PHYS 100 test questions. While we were not able to demonstrate such a correlation due to unforeseen technical difficulties, the project was quite successful in terms of building technical know-how. We are now able to efficiently collaborate with CTLT to automatically retrieve the clickstream data and then analyze it by using a combination of data queries and python programming. The project thus paved the way for potential future research projects on how students interact with our online course resources.

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.*

A) Closely related to this project is our work on open textbooks. This work has been published here:

Hendricks, C., Reinsberg, S., and Rieger, G. (2017), "The adoption of an open textbook in a large physics course: An analysis of cost, outcomes, use, and perceptions" The International Review of Research in Open and Distributed Learning (IRRODL) 18 (4),78.

B) Our work on open education resources including the videos will be part of an upcoming presentation in the Science Supper Series at UBC.

C) A survey that is similar to the one used in PHYS 100 has been administered in PHYS 118. The course also uses a combination of videos and an open textbook, but in PHYS 118 commercial pre-lecture videos are complemented by recommended reading from an open textbook. I plan to write a SOTL-type paper about a comparison between the implementation and use of these course resources in the two courses and discuss results from surveys and focus groups. The main result is that the high integration of custom videos and the customization of the open-textbook in PHYS 100 leads students to highly engage with both resources. By contrast in PHYS 118, the pre-lecture videos (from flipitphysics.com) and the open textbook are not customized. There are marks for watching the videos, but no direct marks associated with reading the open textbook. Despite using examples from the open textbook on worksheets and exams as well as pointing students to highly relevant sections, we found that the students generally did not use the open textbook in

PHYS 118. This emphasizes how much guidance students need in their engagement with resources and how much the absence of marks seems to be interpreted as "not important".

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?*

   I am the designer and instructor of the distance education section in PHYS 100. The videos are therefore an integral part of my teaching practices. As envisioned in the original design of the project, they allow the step-by-step demonstration of expert problem-solving skills. In previous years, this important part of instruction was left to worked-out examples in the textbook. Judging from our survey results, students seem to be much more willing to watch an interactive video than read a worked-out example in the textbook. In addition, the embedded video questions force students to pay attention and engage with these examples. It is not clear in what ways students engage with worked-out examples in textbooks that are "just highly recommended".

   The new videos also support students in the three face-to-face sections of PHYS 100. They could potentially save the instructors some time in class. However, I have not followed up with the instructional team of the fall term to find out whether there were any changes in the content of their lectures or tutorials.
   Regarding sustainability, the videos and all other course materials will be used in the foreseeable future. Since the PHYS 100 course materials form a coherent distance course on edX.edge, they can easily be transferred to other instructors, in case the teaching team changes.

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 video examples created in this projects are embedded in our course website on edX.edge. The video files themselves are hosted on youtube and on Kaltura. The PI also has .mp4 backup copies of almost all video files. There are a few videos that are hosted on a wordpress site that one of the student collaborators has created. I don't expect any problems with any of these technologies in the near future. There are currently no plans to create more videos.