Small TLEF Project – Final Report

Report Completion Date: (2018/05/01)

1. PROJECT OVERVIEW

1.1. General Information

Project Title:	Open ChemE: Increasing authentic student learning through open educational resources
Principal Investigator:	**Jonathan Verrett**
Report Submitted By:	**Jonathan Verrett**
Project Initiation Date:	**2017/03/01** **Project Completion Date:** **2018/04/01**

1.2. Project Summary

This project aims to increase authentic student learning through the curation, development, and provisioning of openly available multi-media resources for CHBE 241: Material and Energy Balances and related chemical and biological engineering (CHBE) courses. The online resources will be used to shift classroom time from content delivery to team-based learning activities. This will make better use of student time in the classroom by supporting students as they undergo the most difficult part of the course of applying course concepts. Additionally, the UBC students will be asked to edit and build upon these resources as part of their coursework, which will create a dynamic, ever-evolving learning resource.

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
Jun Sian Lee	Graduate Academic Assistant	WeBWorK online homework lead
Ruben Govindarajan	Graduate Academic Assistant	Long-answer and wiki page lead
Said Zaid-Alkailani	Undergraduate Academic Assistant	Wiki Notebooks project lead & Jupyter Notebooks project team
Victor Chiew	Undergraduate Academic Assistant	Jupyter Notebooks project team
Ngai To Lo	Undergraduate Academic Assistant	Jupyter Notebooks project team
Siang Lim	Undergraduate Advisor	Jupyter Notebooks project team
CHBE 241 class		Testing and feedback on materials

1.4. 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)

CHBE 241	001	2017/2018 & onwards	Fall

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:
Jupyter Notebook Open Textbook	Notebook code that can be used, modified and edited can be found at: https://github.com/jverrett/CHBE-241 , The online textbook can be hosted by anyone on Syzygy server hosted by Compute Canada which supports the use of Jupyter Notebooks. More on Syzygy can be found at: https://ubc.syzygy.ca/.
UBC Wiki Open Textbook	One of our goals was to centralize resources, we have done this by adapting our original Jupyter Notebook into the UBC Wiki for ease of use for students. This can be openly accessed, copied and modified through the link below: http://wiki.ubc.ca/Documentation:CHBE_Exam_Wiki
UBC Wiki practice problem sets and past exams	Past exams and practice problem sets hosted on the UBC Wiki that can be openly accessed, copied and modified through the link below: http://wiki.ubc.ca/Documentation:CHBE_Exam_Wiki
UBC WeBWorK Problem Sets (60 problems over 6 homework sets)	Currently on the local UBC WeBWorK Server these sets will be published on the WeBWorK Open Problem Library so that they are openly available for use and editing. We are currently going through the revision process and these will likely be available in summer 2018. Once published, the code will be available at: https://github.com/openwebwork/webwork-open-problem-library as well as on the WeBWorK Open Problem Library Browser.

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

The project aimed to create the following tangible deliverables:

Implementation of blended CHBE 241 course

Class time in CHBE 241 will focus largely on group work and student activity following a team-based learning (TBL) model. This will be accomplished using a blended-learning environment including an online textbook, short-answer online quizzes, tutorial videos and a long-answer problem bank. These resources will ensure that student learning is supported outside the classroom allowing classroom time to focus on applying course concepts through group work.

Open Textbook

A complete online textbook freely available consisting of six modules on:

1. Process engineering units, measurement and data analysis
2. Material balance calculations
3. Reactive material balances
4. Phase equilibrium in material balances
5. Energy balances
6. Non-steady state material and energy balances

These modules will also be used as the TBL structure. There is currently an open textbook on the "wikibooks" site which addresses roughly 50% of the course content. Those topics still not complete this resource will be found from other open sources, or if that is not possible, created.

Online quizzes

A bank of questions to use in online quizzes to help students assess their comprehension of materials and give them instant feedback to enhance their learning. These quizzes will correspond to sections of the material found above.

Quick feedback is essential in any learning process. Currently the class has weekly online content quizzes. Our aim is to expand upon these and create multiple quizzes to be able to offer a pre-test and post-test to assess student learning on each of the 6 course modules. Questions may be drawn from the ConcepTests database on LearnChemE.com. LearnChemE is a collaboration between Shell and the University of Colorado Boulder, which hosts resources under a creative commons license.

Tutorial Videos

A repository of relevant online tutorials corresponding to course subjects can significantly enhance student learning. 166 concept and tutorial videos are currently available at LearnChemE.com. We would like to incorporate these into the course and build upon them if necessary.

Long-answer problems

As of yet, we have found no openly available large repositories showcasing practice problems and solutions. However, the Math Department at UBC currently has an excellent system to collect and make available previous exams and teaching assistant certified solutions to students. We would like to continue to search for

practice problem repositories and set up a similar system to that currently used by the Math Department.

3.2. Were these changes/impacts achieved? How do you know they occurred? – *To what extent were intended benefits achieved or not achieved? 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.*

Changes based on the deliverables from section 3.1 above are listed below:

Implementation of blended CHBE 241 course

A move towards more team-based activities was undertaken in the course. Two-stage quizzes were used where students first completed these individually and then as a team. TA time was also shifted from marking assignments towards student interaction in class and tutorials. We will continue to refine these activities in the coming years, but the grant has enabled the development of resources to start a shift in usage of classroom time from content delivery to interaction.

Open Textbook

The online textbook was created in two formats, Jupyter Notebooks and on the UBC wiki. The wiki was an easier format for students to use and this will continue to be developed in future years. The experience in creating Jupyter notebooks however has led to important skills development within the department. A team was put together to create Jupyter notebooks to assist in integrating numerical problem solving with design projects in third year CHBE courses. This team successfully applied for a TLEF titled "Math Doesn't Need to Be Hard: Integrating Experiential Learning and Interactive Online Resources for Chemical Engineering".

Online quizzes

Online quizzes were created on the WeBWorK platform and sixty problems across six problems sets were created for use in the course. We are continuing to build on this and have received funding from BC Campus to produce a further 30 problems for next year's course. In the future both the teaching assistants and instructor plan to create more problems outside of these initial 90. This work also led to collaboration with faculty in the departments of Mechanical Engineering and Electrical and Computer Engineering and the successful application for a TLEF grant titled "Flash Feedback for Second-Year Engineering (FF2E): Personalized Experiential Learning with Instant Feedback Through Shared WeBWorK Resources". These partners have also delivered a number of workshops around WeBWorK at both UBC and BCIT.

Tutorial Videos

Module guides were created for the course indicating resources that support each learning objective in the course. These pointed to tutorial videos and textbook chapters to guide students to more resources should they need.

Long-answer problems

Sample problems and previous exams have been put up onto the CHBE 241 UBC Wiki. Use of these resources can be assessed through page views. Although not all views may have been from students, as some may be from editors, the sheer number of views indicate students used these resources. Views for relevant pages are

listed in the table below:

Page Description	Page Views
Home page	3,862
Final Exam 2016W	807
Midterm 1 2016W	1,207
Midterm 2 2016W	1,327
Module 1 sample problems	1,173
Module 2 sample problems	1,173
Module 3 sample problems	402
Module 4 sample problems	186
Module 5 sample problems	190
Module 6 sample problems	146

3.3. 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.*

The project was disseminated through the following scholarly activities:

1. J Verrett (2017). OpenChemE: Open Educational Resources for Material and Energy Balances. *Proceedings of the Canadian Engineering Education Association Annual Conference (CEEA 2017), Toronto, Canada.*
2. S Zaid-Alkailani, V Chiew, S Lim, J Lo, J Verrett (2017). Flipping Material and Energy Balances using Team-Based Learning. *Proceedings of the 67th Canadian Chemical Engineering Conference (CSChE2017), Edmonton, Canada.*
3. S Zaid-Alkailani, 2nd place, Reg Friesen Student Paper Competition on Educational Experiences. *67th Canadian Chemical Engineering Conference (CSChE2017), Edmonton, Canada.*
4. Winter Institute: WeBWorK for Beginners! Using and Developing for the Open Problem Library, UBC CTLT, in-person workshop introducing the open source online homework platform WeBWorK. Co-facilitated by Dr. Jonathan Verrett, Dr. Agnes D'Entremont, Dr. Negar Harandi, Dr. Luis Linares, Dr. Patrick Walls, 21 participants, 2 hours, Dec 4, 2017
5. S Zaid-Alkailani, V Chiew, S Lim, J Lo, J S Lee, R Govindarajan, J Verrett (2017). UBC Open Chem-E: An Open-Source, Team Based Learning Approach to Chemical Engineering. *UBC Centre for Teaching, Learning and Technology Teaching with Technology Showcase, December 2017.*
6. WeBWorK for Beginners! Using and Developing for the Open Problem Library, British Columbia Institute of Technology (BCIT), in-person workshop introducing the open source online homework platform WeBWorK. Co-facilitated by Dr. Jonathan Verrett, Dr. Agnes D'Entremont, Dr. Negar Harandi, Dr. Luis Linares, 10 participants, 2 hours, Feb 21, 2018
7. J S Lee, J Verrett (2018). WeBWorK as an open online homework system in a second-year material and energy balances course. *Proceedings of the Canadian Engineering Education Association Annual Conference (CEEA 2018), Vancouver, Canada*
8. J Verrett, J S Lee, R Govindarajan, S Zaid-Alkailani, V Chiew, J Lo, S Lim (2018). Open Chem-E: Increasing Authentic Student Learning Through Open Educational Resources. *UBC Centre for Teaching, Learning and Technology Teaching and Learning Enhancement Fund (TLEF) Showcase, May 2018.*

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?*

My own teaching practices have changed significantly by being introduced to various open educational resources and technologies that I have adopted to use in this course. These include UBC Wiki, WeBWorK and Jupyter notebooks which were used in the creation of resources within this project. Through the project a number of other methodologies were explored such as screen-casting and wolfram simulations, examples of which can be found on the LearnchemE.com website. I look forward to continue to build upon these resources in future iterations of the course and continuing to connect with colleagues around open educational resources and practices.

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 course instructor and teaching assistants will continue to use the platforms and resources developed in future course iterations. More WeBWorK questions will be created, the UBC wiki textbook will be refined, long-answer problems and exams will continue to be posted and the library of screen-casts will be updated as new materials come available. The main challenge will be continuing to update and maintain these materials. However, a conscious effort was made in the project to select platforms that are well established such as WeBWorK and the UBC Wiki.