TLEF Project – Final Report

Report Completion Date: 2022/05/24

1. PROJECT OVERVIEW

1.1. General Information

Project Title:	A Dynamic and Integrated Metabolic Map for Teaching Metabolism in the Biological Sciences		
Principal Investigator:	Lindsay Rogers		
Report Submitted By:	Lindsay Rogers		
Project Initiation Date:	May 2020	**Project Completion Date:**	April 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

At the molecular level, life is amazingly complex. The coordinated regulation of thousands of chemical reactions governs all physiological processes across all orders of life. We define these reactions as metabolism. Metabolism describes how we obtain energy from food, how we grow and repair tissues, and how foreign molecules such as drugs are chemically transformed and expelled. Not surprisingly, a myriad of disease states ranging from Diabetes to cancer are associated with defects in metabolism.

The inherent complexity of metabolism makes it challenging to learn. Thousands of chemical reactions are assembled into pathways which are then dynamically interconnected at a particular time. Within undergraduate courses, learners primarily study the details of individual metabolic reactions in isolation. This makes the material manageable but also uninteresting. We predict that focusing less on the chemical detail and more on the overall system will enable learners to connect this material to interesting biological outcomes.

Our team aims to effectively visualize dynamic and integrated metabolic networks within the context of a 3D human cell. Our current network displays eight metabolic pathways. Interactivity enables the user to highlight specific pathways, activate animations visualizing flux through the network, and select individual nodes and edges to access biochemical details relating to each metabolite and metabolic reaction. Our team hosted a formal consultation with UBC undergraduate students to guide design of the network and we have completed two rounds of user testing with UBC students and staff. We are currently working with ISOTL to obtain ethical approval to begin a pilot study to support implementation within UBC biochemistry undergraduate courses. We are also designing a website to host this learning technology and developing learning resources to support open education and widespread adoption by educators and learners.

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
Rosaline Baek	Work Learn	Wikibase & storyboarding
Jazica Chan	Work Learn	Software development
Courtney Clarkson	Work Learn	Project management & UI design
Nikko Angelo Dumrique	Work Learn	Project management & software development
Jenn Gechen	COGS402 Directed Studies	User testing
Ella Gray	Work Learn	Wikibase & storyboarding
Mohsen Movahedi	Coop & Work Learn	Project management & software development
Rayyan Saiyed	Work Learn	Wikibase & audio design
Joshua Spiegel-Brown	COGS402 Directed Studies	Lipid metabolism
Joshua Yoon	Work Learn	Project management & storyboarding
Hai Lin Zhang	Work Learn	Project management & software 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)
BIOC203	001	2022	Winter
BIOC202	951	2023	Summer
BIOC302	951	2023	Summer
BIOC202	001	2023	Fall
BIOC302	102	2023	Fall
BIOC202	002	2023	Winter
BIOC302	202	2023	Winter
BIOC303	001	2023	Fall & 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:
interactive 3D metabolic network	Emerging Media Lab, UBC
3D Metabolism Wikibase	Emerging Media Lab, UBC
Learning resources to support adoption and use	Emerging Media Lab, UBC

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:
Data assaying learning impact	In progress
Resources for instructors to support adoption	In progress

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.*

Impact to students

We hope that this project will impact approximately 1000 students within four of our 200- and 300-level undergraduate biochemistry courses at UBC. Metabolism comprises approximately half of the curriculum within each of these courses. By combining information from multiple textbook figures within an interactive 3D environment, we anticipate that this project will make learning metabolism more interesting and enjoyable. Integrating metabolic pathways and identifying relevant biological outcomes

have consistently been the most difficult learning objectives to meet within these courses. We anticipate that this tool will significantly improve these learning outcomes.

Impact to instructors

This tool will provide a novel resource to instructors both within and outside our department. Through providing a summary of the evaluation of this tool as well as a resource guide for instructors, we anticipate that this learning technology will be used outside our department within courses in biology, pharmacology, biomedical engineering, physiology and medicine.

Impact to UBC and society

Looking forward, we hope this learning technology will be expanded to impact more learners. Several additional metabolic pathways are taught within our 300-level courses. If this initial project is successful, we would like to expand this tool by adding additional pathways to impact much more of our curriculum and support the development of new curriculum. In the long-run, this platform could be adapted and used to support learning metabolism at all levels. This could include high school students, undergraduate students, graduate students, medical students, as well as open education.

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 conducted two rounds of user tests to guide development of this learning technology. However, we have not yet implemented this learning technology into the classroom and collected data to assay learning impact. We are currently working towards this objective in collaboration with ISOTL and Skylight.

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).*

9/16/2020 – Emerging Media Lab Fall Showcase (UBC)

Seminar title: 3D Metabolism

3/31/2021 – Emerging Media Lab Spring Showcase (UBC)

Seminar title: 3D Metabolism

4/26/2021 - 3D Metabolism featured in 2021 Educause Horizon Report

https://library.educause.edu/resources/2021/4/2021-educause-horizon-report-teaching-and-learning-edition

5/17/2021 – TLEF Virtual Showcase

Poster: "A Dynamic and Integrated Metabolic Map for Teaching Metabolism within the Biological Sciences"

9/15/2021 – Emerging Media Lab Fall Showcase

Seminar title: "3D Metabolism"

2/18/2022 – Emerging Media Community of Practice

Seminar title: "Cellular Metabolism in 3D"

4/28/2022 – Emerging Media Lab Spring Showcase

Seminar title: "Cellular Metabolism in 3D"

5/9/2022 – TLEF Virtual Showcase

Poster: "A Dynamic and Integrated Metabolic Map for Teaching Metabolism within the Biological Sciences"

5/12/2022 – Celebrate Learning Week

Panelist event: Immersive Accessibility: A Discussion with Lindsay Rogers and Jon Festinger

7/2/2022 – 6th Canadian International Conference on Advances in Education, Teaching and Technology

Seminar: Cellular Metabolism in 3D

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?*

Because we have not yet implemented this learning technology into courses, my teaching practices have not significantly changed during this project. However, developing this learning technology has caused me to completely reconsider the way we teach metabolism. The learning resources we are designing support higher level learning as compared to our current curriculum.

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?*

We are continuing to develop this learning technology in collaboration with Emerging Media Lab. Staff and faculty at Emerging Media lab continue to support software development, design, and maintenance of the metabolic network. We hope that, through continued funding, this learning technology will be widely adopted as a platform to teach metabolism at all levels. Two significant challenges exist for our team. First, it is difficult to receive funding to support large projects that require several years of development. This project has been supported by multiple funding sources and we hope that this will continue. Second, the network will need to adapt to reflect novel research findings. To achieve this, we have created a Wikibase that links the network to several open external biological and chemical databases.

APPENDIX A: PROJECT COST & EFFORT – *Please update the following project financial details as needed. Kindly keep this section on a separate page, as it will be removed from the public document.*