# TLEF Project – Final Report

**Report Completion Date: (2024/03/31)**

## 1. PROJECT OVERVIEW

### 1.1. General Information

| Project Title: | "Immersive Tools for Field-Based Geoscience Education in Large Undergraduate Courses: Pacific Spirit Forest Augmented Reality field trip and Alpine Ecosystem Virtual Reality tours" |
|---|---|
| Principal Investigator: | Nina Hewitt |
| Report Submitted By: | Nina Hewitt |
| Project Initiation Date: | 2019/04/01 |
| Project Type: | ☐ Large Transformation<br>☒ Small Innovation<br>☐ UDL Fellows Program<br>☐ Hybrid and Multi-access Course Redesign Project<br>☐ Other: [please specify] |

Additional columns for Project Initiation Date row:
| | Project Completion Date: | 2024/04/01 |

### 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** – *What did you do/change with this project? Explain how the project contributed toward the enhancement of teaching and learning for UBC students.*

Geoscience education is rooted in experiential, field-based learning. However, short class times, large student numbers, variable TA expertise and distance to field sites hinder outdoor education in large undergraduate courses. GEOS102 Introduction to Climates and Ecosystems, for example, has just one field activity (to nearby Pacific Spirit Forest), which must be delivered in multiple 50-minute sections by TAs with varying knowledge. Immersive technology can overcome these challenges by using Augmented Reality (AR) in actual field trips and Virtual Reality (VR) for sites too remote to visit. This project will expand a self-guided, mobile app-assisted AR version of the existing Pacific Spirit Forest field trip and create a set of 360° virtual field trips to BC coastal forest and alpine ecosystems. Highlighting basic ecological concepts and human impacts, these tools will offer immersive, visually rich education about BC's changing ecosystems suitable for use or emulation across undergraduate geoscience curricula.

**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 |
|---|---|---|
| Brian Wilson | Curriculum Manager at UBC Vantage College and Former Director, EML | Co-investigator and co-developer for the Pacific Spirit AR |
| Sally Hermansen | Prof. Teaching (Emeritus) Geog | Collaborator on Karakoram StoryMap |
| Stepan Wood | Professor, Allard Law, UBC | Volunteer, photos, videography, field assistance: Alpine VRs in S Chilcotins, Manning, Garibaldi Provincial Parks; Pacific SP VR |
| Geog Tech Team – Incl. Kellen Malek, Andrew MacDonald, Jose Aparicio, Eric Leinberger | Various – Geog IT team | Malek: Compute Can. workflows; MacDonald: 3D Vista software; Aparicio: Storymap accounts; Leinberger: map illustrations |
| Cassandra Elphinstone | PhD Candidate, UBC Biol and Geog | Collaborator on Garibaldi |
| Sarah Peirce (U of T) | Assistant Professor of Teaching, University of Toronto | Collaborator on High Park tours |
| Siobhan McPhee | Associate Professor of Teaching, UBC | Peer Mentor (to Hewitt) and AR tours consultant |
| Leilani Forby | SoTL Graduate Assistant | SoTL Specialist on Seed project , Pacific Spirit VR impacts |
| Henry Davis, Gitlab | Professor, Linguistics | Collaborator, Gitskan H5P |
| Olive Wu | | Undergraduate project assistant, Gitskan H5P |
| Kelly Hurley | Student, BA candidate | Undergraduate project assistant on Augmented Reality Pacific Spirit |

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|---|---|---|
| | | Park tour; Karakoram historical google earth tour |
| Emily Ballon | Student, BSc candidate | Undergraduate project assistant on South Chilcotin Mountains VR - Unity programming and narrative materials assistance; 2 H5P webpages for GEOG 319 |
| Samantha Loo | Student, BSc candidate | Undergraduate project assistant, H5P webpages for GEOG 319 |
| Angela Liu | Student, BA candidate | Undergraduate project assistant on Karakoram DEM and Storymap |
| Holly Denson Camp | Student, BSc candidate | Undergraduate project assistant on H5P, Unsettling Conservation and others for GEOS 307 |
| Andrea Sze | Student, BA candidate | Undergraduate project assistant on Manning Park VR |
| Andrew Yan | Student, BSc candidate | Undergraduate project assistant. 3D Vista and Storymap for Manning Park and High Park Oak Savanna VRs – programming, narratives, media co-production |

**1.5. Courses Reached** – *Please fill in the following table with __past__ and __current__ courses (e.g., HIST 101, 2017/2018) that have been reached by your project, including courses not included in your original proposal.*

| Course | Academic Year |
|---|---|
| GEOB 102 101 | 2019/20 Sep |
| GEOB 102 201 | 2019/20 Jan |
| GEOB 102 101 | 2020/21 Sep |
| GEOG 319 101 | 2020/21 Sep |
| GEOB 102 102 | 2020/21 Jan |
| GEOB 307 201 | 2020/21 Jan |
| GEOS 102 101 | 2021/22 Sep |
| GEOG 319 101 | 2021/22 Sep |
| GEOS 307 201 | 2021/22 Jan |
| GEOS 102 201 | 2021/22 Jan |
| GEOS 102 101 | 2022/23 Sep |
| GEOG 319 101 | 2022/23 Sep |
| GEOS 102 201 | 2022/23 Jan |
| GEOG 319 101 | 2023/24 Sep |
| GEOS 307 201 | 2023/24 Jan |

## 2. OUTPUTS AND/OR PRODUCTS

**2.1.** *Please __list__ project outputs and/or products (e.g., resources, infrastructure, new courses/programs). Indicate a URL, if applicable.*

| Output(s)/Product(s): | URL (if applicable): |
|---|---|
| Pacific Spirit (Forest) AR | • https://explore.echoes.xyz/collections/r6plvKbxHPid9QKd ;<br>• Companion Website at:<br>https://blogs.ubc.ca/alpineplants/augmented-field-trips/pacific-spirit-echoes-ar-tour-companion-website/<br>• Original tour built into Motive.io but this software was discontinued. Archived content here:<br>https://blogs.ubc.ca/alpineplants/forest-explore-ar-coastal-douglas-fir-forests-pacific-spirit-forest-bc/<br>• Publication about student response and impact here:<br>https://www.tandfonline.com/doi/full/10.1080/00330124.2022.2134151<br>• Video production for Open Education Resources (OER) showcasing field research about BC coastal forests to accompany tours:<br>"In Conversation with Joyce Leung (President) and Laura Cottle (Volunteer Program Coordinator), Pacific Spirit Park Society", at:<br>https://youtu.be/e6NjfrydOOw?si=vi1owLIciCyK77NK |
| Pacific Spirit (Coastal Forest) VR | https://opentextbc.ca/geoglabmanualv2/chapter/biogeography-coastal-forest-virtual-field-trip/ and https://ubc.tapestry-tool.com/spatial-xp/tapestry/field-trips/#/nodes/183?depth=1; 360 portion only, here: https://blogs.ubc.ca/alpineplants/interactive-360-pacific-spirit-tour/ |
| Alpine VR 1 - South Chilcotin Mountains Tour | • via Hewitt website: https://blogs.ubc.ca/alpineplants/alpine-vr-southern-chilcotins/ (directly via Simmer.io:<br>https://simmer.io/@Hewitt_Lab/alpinevr)<br>• Example Assignment (hosted in Canvas but duplicated in Google drive for sharing:<br>https://docs.google.com/document/d/1zPVoGR94cqI4u6HSy9Fth13kTeTGdraiFN2iZyYfJ5o/edit?usp=sharing<br>• Google Earth Tour developed to complement the lab assignment:<br>https://earth.google.com/earth/d/1dOKxjs1WixsLG-l0BMEvViQyG-eMVAqT?usp=sharing |
| Alpine VR 2 - Elfin Lakes Tour | • Hewitt website: https://blogs.ubc.ca/alpineplants/elfin-lakes-tour/ |

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|---|---|
| | • Via TapestryTool embed: https://ubc.tapestry-tool.com/geos307/wp-admin/admin-ajax.php?action=h5p_embed&id=17 |
| Alpine VR 3 - Manning Park | • Manning Park Storymap with 3D Vista tour: https://arcg.is/0yDyqf0<br>• Arbutus Object (just hosts 360 3D Vista tour): https://www.mail.ubc.ca/owa/redir.aspx?REF=oxtHSnm6Rx7f-Q_OrblwAwgbdS7XGaBrKN19Jn7vUSSaWr0W7kbcCAFodHRwczovL29iamVjdC1hcmJ1dHVzLmNsb3VkLmNvbXB1dGVyYW5hZGEuY2EvZ2FyaWJhbGRpIvbWFubluZ3ZyL2luZGV4Lmh0bQ;<br><br>• On Hewitt webpage: https://blogs.ubc.ca/alpineplants/virtual-field-trips/manning-park-alpine-meadows/ |
| Video production for Open Education Resources (OER) showcasing experts conducting field research about alpine ecology and climate change to accompany my VR tours (under my TLEF Grant): | • Alpine Plant Biodiversity and Climate Change Study with Courtney Collins and Cassandra Elphinstone, https://youtu.be/MegAfCpwAN4<br><br>• In Conversation with Prof Lizzie Wolkovich and Deirdre Loughnan (UBC Forestry Temporal Ecology Lab), https://youtu.be/E7NK0NSk_mM<br><br>• Katie Goodwin (UBC Botany) discusses alpine lupine populations in Manning Park: https://youtu.be/TsZ7mO78EaE<br><br>•Mackenzie Urquhart-Cronish (UBC Botany) discusses pink monkey flower research in the BC alpine: https://youtu.be/rXnq9PAptXQ |
| Interactive DEM and Storymap about Karakoram alpine plants for GEOS 307 | •https://storymaps.arcgis.com/stories/9ee24a55c59442f1a19742b3207d1d4b |
| Note that the Alpine VR come with several related resources that my team built including<br>- BC Alpine Taxa Webpages (to complement tours)<br>- iNaturalist site<br>- Alpine Plant Adaptations resource (to complement tours)<br>- and more - see webpages for tours | • Hewitt webpage: https://blogs.ubc.ca/alpineplants/bc-taxa/<br>• via iNaturalist: https://www.inaturalist.org/observations?place_id=any&user_id=nhewitt&verifiable=any and https://www.inaturalist.org/projects/garibaldi-alpine-plants<br>• Plant adaptations: https://blogs.ubc.ca/alpineplants/alpine-plant-adaptations/ |
| High Park Oak Savanna AR and VR | • Storymap at: https://arcg.is/0SuuuT<br>• Hewitt webpage draft with context at: https://blogs.ubc.ca/alpineplants/virtual-field-trips/high-park-black-oak-savanna-tour/ |

| | |
|---|---|
| Toolkit for Storyboarding tours with instructions and templates, created for a SEEDS toolkit and shared with other VR creators at UBC | • Google drive with storyboard and templates: https://drive.google.com/drive/folders/1Adb8gblu4uLfcVC605sS8VuPEywEmqlK?usp=drive_link |
| Interactive H5P Web-Pages built for OER learning during the pandemic; served as springboard for those created for other courses via OER grant. 1) for GEOS 307 • Indigenous Conservation H5P book • Alternative to Linnean Plant classification H5P with Gitxsan (Gitksan) illustration | • Unsettling Conservation H5P page: https://ubc.tapestry-tool.com/geos307/wp-admin/admin-ajax.php?action=h5p_embed&id=18 • Alternative to Linnean Plant classification with illustration from Gitxsan (Gitksan) - this resource is not OER given sensitivity of Indigenous Knowledges; while the information is published elsewhere (in Turner et al.) the resource itself is purely for instruction within GEOS 307; link available to TLEF staff only; or if knowledge sharing protocols with the Gitksan are sought and met) |
| 2) for GEOS 319 | • Impact Assessment Tapestry: https://ubc.tapestry-tool.com/geog319-001/tapestry/geog-319-environmental-impact-assessment/#/nodes/792?depth=2 • Includes content to address power, place, Indigenous equity and inclusion, e.g., Week 5 features information about Muskrat falls; Week 8 about Indigenous consultation and the need for consent |

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

| Item(s) Not Met: | Reason: |
|---|---|
| High Park, Toronto, Oak Savanna VR, AR: We met all of our objectives but are waiting for materials from the High Park Conservation Team | The HP Restoration team sent their narration script to the Toronto parks administration and have not received the go ahead. Once they have, the restoration team will record their audio narrations and we will insert at each stop and program them into the AR app. This item (the High Park tour) was actually an extra item we proposed after our original proposal and so is actually in addition to our original goals. |

## 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-satisfaction

☒ Teaching practices

☒ Student wellbeing, social inclusion

☒ Awareness and capacity around strategic areas (Indigenous, equity and diversity)

☐ Unit operations and processes

☐ Other: [please specify]

**3.2. Please provide details on each of the impact areas you selected in 3.1.** – *For example, explain in which ways your teaching practices changed; how student wellbeing was impacted; how students wellbeing benefited from your project, etc.*

Teaching Practices. The digital tours have innovated my own teaching practice. Since these are somewhat distinct in their nature, user groups, and impacts, I treat examples and impacts for individual tools below: *The Pacific Spirit Forest AR and VR tours* converted an in-person, TA-led field trip on plant succession and disturbance in Pacific Spirit park in GEOS 102, into an mobile-app guided walking tour. In 2022 my team redesigned and programmed the tour into new software, Echoes AR (tour here) and created a companion website when the Motive.io AR software became obsolete. This effort updates and maintains the currency of this digital immersive experience. At the onset of the pandemic, Hewitt rapidly translated the trip into a Pacific Spirit VR (Hewitt 2021) so students would be able to run this experiential activity during lockdown. **Impacts:** The AR tour extended the use of AR technology in the department to a geoscience field trip (which had been applied for human geography topics by SM). Anonymous student feedback remarked on the AR tour's accessibility, flexibility and rich content, in comparison to the conventional TA-led version (see below). And the workflow and product has been shared with other instructors to inform their own (see below). The VR tour, now part of a peer-reviewed Laboratory Manual for introductory Physical Geography courses (MacKinnon et al 2020; 2021), is one of several labs designed to be "implemented within first year post-secondary physical geography courses [with] easily adapted for various course structures, durations, and differing laboratory learning objectives set out by instructors" (OER Champions description 2022), and continues to serve those audiences at institutions including UBC, University of Victoria and College of the Rockies. It also serves our own students in ongoing course sections whenever they cannot complete the regular in-field tour. Feedback from instructors from other institutions (Kathy Peet) shows it has been very well-received. This effort has reshaped my approach to experiential learning in the classroom and beyond.

*Southern BC Alpine VR tours* These sourthern Alpine ecosystems include: S. Chicotins Alpine VR that takes students along a 5 km route into an alpine landscape in the South Chilcotin Mountains. The 9 tour stops ascend from subalpine forest at 1500 m elevation to an exposed ridgetop at 2200 m, and end in a lush alpine meadow at 1900 m. Students explore landforms, ecology and human-environment interactions via 360° and high resolution 2D photos, instructional videos and drone footage, as well as text narrations, quizzes and links to scholarly literature and Web resources. Accompanying resources (my alpine flora of BC webpages and a Google Earth Tour) allow students to delve deeper. This tour was the product of a year-long effort to

conduct background research, produce visuals and quizzes, create a storyboard and program the tour in Unity. Hewitt has used it in GEOS 307 Biogeography since W2 2020 (see example Assignment duplicated in Google drive, above). **Other Impacts:** Students have responded very positively to the novelty, flexibility and visual richness of the South Chilcotin VR tour, and their field trip reports were truly stellar with detailed field observations, learning objects (eg, botanical sketches, labelled diagrams) and connections to course concepts. I have shared this resource and my methods for creating VR tours with the wider university and academic community, members of UBC Forestry (who consulted me on the design of their virtual field camp and included my tour as a background resource in their online capstone alpine field course), glaciologist Derek MacDougall of the University of Worcester, who creates geomorphology VR tours, and participants in a May 2021 Celebrate Learning Week event that I co-organized.

_Another 2 Alpine tours (above)_ programmed using H5P and 3D Vista (in 2024) explore Coastal Mountain-Heather alpine zones at Elfin Lakes and Manning Park (includes 360° videos). These tours present instructive ecological and social contrasts with the South Chilcotin tour and is an in class experiential activity in GEOS 102 and 307.

_Other:_ Dakota Bowl VR tour. In Fall 2020, I created a VR tour of a Western Hemlock-Yellow Cedar old growth forest in the logging-threatened Dakota Bowl on the BC Sunshine Coast, as part of a collaborative effort with Elphinstone Logging Focus and Forests of the Future aimed at forest preservation and community education. I have used this tour as a co-curricular resource in GEOS 102 and 307. Impacts: Students were energized by this resource and some said it prompted them to consider participating in grassroots forest protection campaigns. The tour was featured in the Living Forest Institute's outreach campaign, a Sechelt Art Gallery exhibit (Oct. 2020) and a Sunshine Coast Arts Council Education program (Feb 2021).

_UBC Campus Tree Who's Who VR tour_. This co-curricular resource is a digital tour and fun knowledge test, which combines information on forest ecology with digital tour technology to provide an interactive educational experience in keystone and urban forest tree species identification. Impacts: This tour was created for a SEEDS/CCUB/Botanical Garden Biodiversity and Climate Action Ideas Showcase (May 2021), was received enthusiastically by the 56 attendees, and will likely be used and built upon by SEEDS in future workshops.

_Interactive H5P webpages with Tapestry Tool_: These interactive html webpages complement course modules (see examples in the tools listed above). Students were enthusiastic about these resources in anonymous feedback surveys (GEOG 319) and in-class Zoom chats (GEOS 307), noting their real-world context, immediacy and engaging nature.

_Karakoram_ ESRI Storymap with QGIS DEM: allows students to interact with floristic data for the Karakoram, providing a hands-on, active learning in-class experiential activity in GEOS 102 and 307 that showcases student work (my UG project assistant) and supports lessons about alpine species' range responses to climate change; as do the various Google Earth Tours developed to complement lab assignments such as the Alpine VR (see above). **Impacts:** These resources build upon Hewitt's biogeographic research, and feature annually in GEOS 307. Students report anecdotally that these resources enrich their learning experiences.

Student wellbeing and inclusion: The AR and VR tours were specifically designed to increase student access to digital experiential ecosystem learning – to allow field experiential learning in an accessible manner to sites students actually visit (via AR) or to sites that students cannot visit due to physical challenges of access or mobility (VR). For example, the Pacific Spirit AR and VR tours allow GEOS 102 students with temporary physical issues, and or student cohorts during pandemic conditions to experience the site, and allow access; and the Alpine VR to the S. Chilcotins in my GEOS 307 course allows students an experiential module in a physical space that is infeasible to visit within the constraints of the regular course. The success of these elements at this goal is discussed below, and documented in, e.g., Hewitt et al's (2023) SoTL study of the Pacific Spirit AR focus group study; and other presentations listed below (e.g., see below, "Conventional, Augmented and Virtual Reality Field Education in the Biogeosciences: Comparing Student Perceptions and Performance." AAG Annual Meeting, 2021). Student feedback has also indicated the value toward inclusion, with EAL students particularly noting the value of the media that they could access at their own pace and as their schedules permit (e.g., see Hewitt et al 2023). The H5P webpages (eg here and here) provide free, quality learning resources to support student access and performance (Hendricks et al 2017; UBC Strategic Plan). Students have appreciated the flexibility and knowledge-scaffolding these afford in surveys and SEoT comments.

Instructional Team Satisfaction: These open educational resources are used in my own courses to increase satisfaction of the instructional team. For example, the Pacific Spirit Park VR has been used by several instructors to facilitate field experiences in our GEOS 102 throughout 4 terms of pandemic impacted learning (instructors Williams, Hewitt, McKendry, Knox and Pearson during 4 separate teaching terms when in person instruction was prevented). TAs in the course use the tour to standardize their in-field delivery during in person terms. Finally, we provide the VR to students as a supplement to the field trip, which we share after in field tours run. As Hewitt et al (2023) report, the in field experience suffers in some respects and benefits from this additional support.

Additionally, the VR tours are used, and potentially useful in a range of undergraduate courses in biogeography, botany and ecology. For example, the Pacific Spirit Park VR has been used by several instructors who use the lab manual (e.g., instructors at UBC O). The workflow we developed has been shared with other faculty to expand their repertoire and innovate their teaching methods. The toolkit for Storyboarding VR (360) tours with instructions and templates, created for a SEEDS toolkit has been shared with other VR creators at UBC. For example, Geog Prof Avi Lewis's RA applied this to guide the storyboarding of the digital land acknowledgment featuring Grand Chief Reuben George; Lewis reports that his own tour, used annually in GEOG 302, is a smash hit. I have also shared the PSP tour with Pennsylvania State University Architecture faculty; showcased, it along with AR tours by S. McPhee (Geography) and K. Lyon (Sociology), in the global Educause Horizon Report, Teaching & Learning Edition (2020); and in various UBC teaching workshops (see below)

Awareness and capacity around strategic areas (Indigenous, equity and diversity): My lab also developed course elements to combine with the other digital materials. These included google earth web tours, and H5P interactive webpages for GEOS 307 and 319, that served as pilots for the subsequent development of similar materials for GEOS 102 and 374 under a separate OER fund. Several of the H5P pages specifically address power, place, and the inclusion of ways of knowing that feature Indigenous approaches, e.g., the GEOG 319 Week 5 module features information about Muskrat falls; Week 8 is about Indigenous

consultation and the need for consent; The GEOS 307 book, "Unsettling Conservation" and H5P page devoted to providing students with alternatives to Linnean biological classification with an example of Gistkan plant classification (see links above). Given the sensitive nature of OER devoted to Indigenous knowledges, this latter resource is not available openly, but has served my students in some capacities.

**3.3. How do you know that the impacts listed in 3.1/3.2 occurred?** – *Describe how you evaluated changes/impacts (e.g., collected survey data, conducted focus groups/interviews, learning analytics, etc.) and what was learned about your project from the evaluation. You are encouraged to include graphical representations of data and/or scenarios or quotes to represent and illustrate key themes.*

We have applied several methods to obtain feedback on impacts. These include:

- Anonymous feedback surveys, e.g.,
    - A BREB approved, SoTL Seed fund supported, comparative study of the Pacific Spirit VR's effects on learning and engagement employing pre- and post-knowledge testing quizzes; and surveys of engagement (Hewitt, Forby et al, in progress)
    - anonymous surveys and observations of focus group participants that ran the Pacific Spirit AR (see Hewitt et al 2023 for results)
    - Qualtrics surveys of engagement in H5P webpages in GEOG 319 (results available on request); and GEOS 102
    - In-class Zoom chats and anonymous menti-polls about the Alpine VR (GEOS 307) (see poster presentation, listed below)

Anonymous SEoT also provided feedback in the form of anonymous commentary specifically about the tours. Examples are available upon request.

The results were overwhelmingly positive, showing that students appreciated the flexibility, the opportunity to learn independently and access materials outside of the tours including transcripts (especially for EAL students), as reported in Hewitt et al. 2023; and Hewitt, Forby, in progress, both listed below.

We solicited responses on the Chilcotin Mountains VR Lab in GEOS 307 and received similarly positive responses as presented in Hewitt's poster at the BC Provincial Geoscience Fair, Jun 15, 2021 here "Integrating Experiential Ecosystem Education into Remote Biogeography Teaching."

Our surveys of the GEOG 319 H5P webpage responses were very positive, but students wished for more integration of responses into Canvas (the Tapestry H5P system does not allow that). Nevertheless, grades on course sections have risen since adding these; and student engagement, as measured in SEoTs scores and comments, has markedly improved since including these resources to support learning.

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?*

Hewitt's teaching practices have changed dramatically through this fund and its products. Hewitt has implemented more effectively blended learning approaches with the interactive H5P pages (Tapestries) to

support and scaffold learning in lesson modules; And to include Field Experiential to sites that are not accessible (with my Alpine VR). Hewitt and other team members (Wilson) have shared the lessons, workflows for digital tool storyboarding, and other techniques partly that this project helped develop with other instructors, including: In presentations about teaching practices at local (e.g., CTLT) and International (AAG) conferences (see presentations below); in meetings with faculty from e.g., Forestry to inform the development of their their alpine ecology virtual field camp (2020 spring); EOAS; TLEF EASEIL project (that actually used my 360 camera to create their digital tour of the UBC Tech field station with advice from our toolkits and team); with members of Mech Engineering upon request as they planned their AR materials. Hewitt lab created co-curricular materials including a campus trees Who's Who for a knowledge engagement workshop by SEEDS that was run by dozens of participants. And the cross-Institutional effort toward a Physical Geography Lab manual involved sharing of techniques and materials during and post manual development. See other examples above in section 3.2 for how Hewitt's teaching practices have changed and affected those of others.

The changes are sustainable – Hewitt continues to use the tools in related projects in which she is involved. For example, in BC Parks Climate Change and Conservation Grant on which Hewitt is co-investigator, which produced an ESRI Storymap and digital tour of the alpine ecology field research informed by this work, available here: https://storymaps.arcgis.com/stories/1d2d72081b4f45bf91a35c6fecef47d9) to be presented at an upcoming International Tundra Experiment (ITEX) conference in Vancouver (Apr 10-12, 2024). Other examples provided above.

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 project sustainment?*

The sustainment of this project is possible through the dissemination of media via Open Access, Creative Commons licenced resources; by Hewitt's continued use of the resources in 3 courses (GEOG 319; GEOS 102; 307); through publications that include them (MacKinnon et al 2021); and by communications with other Instructors to share them in similar courses. The open online platforms and other means allow these tools to be hosted in a sustainable fashion, at least to the extent that such media are "permanent". These include:

- Hosting on Tapestry.tool (the H5P webpages) platform which is supported by UBC.
- Included in that is the Geography Virtual Spatial Experiences Tapestry (https://ubc.tapestry-tool.com/spatial-xp/tapestry/field-trips/#/nodes/167?depth=1) that hosts my Pacific Spirit VR and other 360 tours.
- Hosting of our Physical Geography online lab manual (MacKinnon et al 2021) via BC Campus, which has now housed it in their BC Open Collection (see links below)
- Hewitt obtained an account on Compute Canada to host the 3D Vista tours (2024), and her lab, with the GEOG IT team, developed a workflow to upload and host the 360 tour as an Arbutus Object.
- Hosting on Hewitt's personal website. While this is less "findable" than larger public websites, it assists with sharing and responding to requests for access from users for resources not found on the platforms above (e.g., GoogleEarth Web Tours, StoryMaps, Echoes AR, 3D Vista) which themselves are maintained by large tech companies (Google), and funded by ongoing software subscriptions at UBC.

- Publications and papers have led to connections that allow for dissemination and sustainment.

Hewitt will continue to employ these resources and share the URL's with co-instructors on the courses listed above to sustain their use. We anticipate that some challenges associated with websites that may not be searchable or posted on central websites. We welcome suggestions from TLEF for sustainment.

6. **DISSEMINATION** – *Please provide a list of 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). These will be included on the TLEF scholarly output page.*

*Scholarly Articles:*

- **Hewitt, N**., S. Wood and B. Wilson. 2023. Ecosystem education with Augmented Reality: A flexible tool for in-field learning. *Professional Geographer*. 75(4):577-590. https://doi.org/10.1080/00330124.2022.2134151
  - We presented the results of 2 focus group studies of student response to the AR in GEOS 102.
  - Tweeted by the American Assoc Geogs here: https://twitter.com/theAAG/status/1702413430580211978?t=8J_62dYq5tP9A12HhBQPOA&s=19
- In Progress: **Hewitt, N**., Forby, L., et al. Immersive Tools for Field-Based Geoscience Education in Large Undergraduate Courses: Pacific Spirit Forest Virtual Reality tour. for Natural Sciences Education (funded by a SoTL Seed fund)

*Lab Manuals*

- **Hewitt, N**. 2021. Lab 12: Coastal Forest Virtual Field Trip. and Instructor Notes. In ibid. Available at: https://opentextbc.ca/geoglabmanualv2/chapter/biogeography-coastal-forest-virtual-field-trip/
  - • https://collection.bccampus.ca/textbooks/laboratory-manual-for-introduction-to-physical-geography-second-edition-bccampus-401/ (BC Open Collection website). This lab drew on the VR version of the PSP tour Hewitt created in response to the sudden remote transition, 2020. It was not initially planned in the TLEF, but followed from the work on the AR tour for this project.

*Presentations*: (by Hewitt, unless indicated)

- Hewitt, N. Invited Speaker, "Flexible, immersive and interactive modules to create hybrid learning environments in the geosciences", session "Hybrid and multi-access courses in Arts", Arts ISIT Welcome Back Conference, https://isitworkshops.arts.ubc.ca/events/event/hybrid-multi-access-courses-in-arts-arts-isit-welcome-back-conference/ , Aug 16, 2023
- Hewitt, N. Presenter "Immersive Tools for Field-Based Geoscience: Augmented and Virtual Reality Tours to Coastal Forests and Alpine Ecosystems" (with Wilson) 2023 TLEF + ALT-2040 Virtual Showcase, May 4, 2023
- Hewitt, N. Presenter SoTL research comparing in person to virtual reality field experiences. UBC SoTL Round Table, (SoLT Seed cohort), Nov 16, 2022 (online).
- Hewitt, N. Poster "Integrating Tools for Geospatial Alpine Ecosystem Education into a Remote Biogeography Classroom." American Association of Geographers Annual Meeting Virtual Poster Session, Feb 25, 2022.

- Hewitt, N., Presenter "UBC Campus Tree Who's Who VR tour", SEEDS/CCUB/Botanical Garden Biodiversity and Climate Action Ideas Showcase (May 2021)
  - Employs a co-curricular resource Hewitt created, the UBC Campus Tree Who's Who, combining forest ecology information with digital tour technology and fun knowledge tests to provide an interactive educational experience about keystone and urban forest tree species identification; received enthusiastically by the 56 attendees, and available for future workshops.
- Hewitt, N., Presenter "Conventional, Augmented and Virtual Reality Field Education in the Biogeosciences: Comparing Student Perceptions and Performance." AAG Annual Meeting Virtual Sessions, Apr 10, 2021.
- Hewitt, N., Panelist (with R. Shakespeare, K. Kemp, E. Cleasby, J. Barr (and 2 others), "How? Options for VR tech for tours" In "Virtual Field Trips." Geographies of Access: Inclusion and Pathways theme, American Association of Geographers Annual Meeting Virtual Sessions, Apr 8, 2021. https://aag.secure-abstracts.com/AAG%20Annual%20Meeting%202021/sessions-gallery/27632
- Hewitt, N., "Integrating Biogeographic Research and Teaching with Digital Technologies" Green College Leading Scholars' Series: Academic Appetizer Hour (Virtual) Feb 17, 2022.
- Hewitt, N., Poster presentation (with L. Forby) "Conventional vs VR Field Education in the Biogeosciences:
- Hewitt, N., Comparing Student Perceptions and Performance", Celebrate SoTL Showcase, UBC 2021, Oct 17. Available at: https://isotl.ctlt.ubc.ca/celebrate-sotl-2021/
- Hewitt, N., Presenter, "Piloting a digital alpine ecosystem tour for online experiential learning in the biogeosciences," BC Provincial Geoscience Fair, organized by Dr. C. Huscroft, Thomp. Riv. U, Jun 15, 2021
- Hewitt, N., Poster Presentation "Integrating Experiential Ecosystem Education into Remote Biogeography Teaching." CTLT Celebrate Learning Week, ELNET Session, May 17 pm, 2021 (same day as the TLEF showcase, below).
- Hewitt, N., Poster presentation, "TLEF Sub-Project: Interactive Alpine Ecosystem Module with ESRI Storymaps," 2021 TLEF Virtual Showcase, May 17 am, 2021. Available at: https://tlef2.sites.olt.ubc.ca/files/2021/05/2021-TLEF-Showcase-ARTS-Nina-Hewitt.png
- Hewitt, N. Organizer and presenter (with B. Wilson, Vantage College), "*Using immersive technology field trips to bring the class to the world and the world to the classroom*", Roundtable Session at First Year Experience Educators' Symposium, Feb 20, 2020. Peer reviewed and competitively selected proposal.
- Hewitt, N., "Ecosystem Education with Augmented Reality: Value-Added Learning or Student Disengagement?" American Association of Geographers Annual Meeting, Washington DC, Apr 2019.

*Sessions Organized:*

- Hewitt, N., Organizer (with S McPhee) and Panelist: "Critical perspectives on emerging technology and digital literacy." (with S McPhee, M Jerowsky, L Brown and E Fraser (UCal Berkeley), Reciprocal Scholarship series, American Association of Geographers (AAG) Annual Meeting, Honolulu, Apr 19, 2024. Panel Session.
- Hewitt, N., Organizer (with S McPhee), "Transformative pedagogies: VR and AR for online, blended and experiential learning post-Covid." AAG Meeting April 2021; Organized Paper Session.
- Hewitt, N., Organizer (with S McPhee), "Critical Geographies of Education: Why bother with Educational Technologies?" AAG Annual Meeting, Washington DC, Apr 2-6, 2019.