Creating a Virtual Field Trip Experience for Tertiary Students[1]

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INTRODUCTION

Fieldwork has been identified by many as one of the most crucial pieces of learning for students in science fields like geology, biology, geography, etc. (Fuller et. al, 2006). In a world that continuously advances technologically, virtual field trips are becoming more sophisticated and effective forms of teaching. Some argue that it would be difficult for virtual field trips to completely replace the experience of doing real fieldwork and argue that instead, virtual field trips could function best as a supplement to fieldwork (Çaliskan 2011, Maskall & Stokes 2009, Rose et al. 2007, Spicer 2001). However, there is no doubt that the benefits of virtual field trips outweigh their disadvantages; they are cheaper, safer, and provide learning opportunities for students with mobility limitations (Atchison et al., 2011), learning disabilities (King-Sears, 2009), and economically disadvantaged students. Universal Design for Learning (UDL), a global learning framework developed in the 1950s, stresses the importance of making learning environments more accessible to students (Rose et al., 2007).

The majority of literature available on VFTs mostly deals with the role and/or effectiveness of VFTs in the Earth sciences. Some specifically address their role in Tertiary classrooms, which is very relevant to this project. Articles range from dealing with the more abstract concept of virtual field trip education to the specific differences between virtual and actual field trips (Hurst, 1998). Those who research virtual learning environments seem to agree that there a few key components of VFTs that are essential for an effective experience for students, including: thoughtful and sufficient preparation (Bricken 1991, Browne 2005, Lacina 2004, Woerner 1999) clear and specific objectives (Woerner, 1999), active student participation (Browne 2005), a feeling of "presence" (Mikropoulos & Natsis, 2011), multimedia content (Mikropoulos & Natsis 2011, Liaw 2007), collaboration with other students (Mikropoulos & Natsis, 2011, Woerner, 1999), guidance (e.g. from an instructor) (Browne, 2005), challenging activities (Liaw, 2007), and an easy-to-navigate website that provides ample background information (Woerner 1999, Lacina 2004, Slator 1999). This paper will discuss the ways in which a LEARNZ VFT experience would theoretically be as effective for Tertiary students as it is for Primary and Secondary students. The VFT is set to go from August 9th-11th, 2016 and the GEOL 113 workshop will happen that weekend.

The focus of this study is to evaluate how we can design a virtual field trip with LEARNZ for Tertiary students. LEARNZ is an organization run by CORE Education that creates virtual field trips for Primary and Secondary students in New Zealand. The work for this project involves developing a virtual field trip (VFT) with LEARNZ for the students at University of Canterbury enrolled in GEOL 113: Environmental Geohazards, an introductory-level geology

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course. GEOL 113 looks closely at the Alpine Fault, as it is due to rupture sometime within the next 50 years and would be especially devastating to New Zealand's West Coast. The workshop is intended for students to think about what they know about the Alpine Fault and think crucially about how a future rupture would affect an important industry on the West Coast (mining, tourism, or dairy farming).

METHODS

Studies have shown that creating clear and specific learning goals is overwhelmingly beneficial for both students and instructors; students find that having learning goals outlined helps them with learning and studying (Simon & Taylor 2009). Foundational to this project was the creation of learning goals that were carefully crafted using materials from the GEOL 113 workshop (lectures, worksheets, assessment guidelines, etc.) that will take place the weekend after the virtual field trip. Collaboration with Tom Wilson (the GEOL 113 professor), Ben Kennedy (who organized the partnership between UC and LEARNZ), Sam Hampton (who has taught GEOL 113 in previous years), Pete Sommerville (who creates VFTs for LEARNZ), and Shelley Hersey (who is the LEARNZ field trip "teacher") were essential to creating the learning goals for this project. The diagram in Figure 1 shows all of the necessary components used in creating learning goals.

We were able to create background pages based on key learning goals from the GEOL 113 class as well as LEARNZ's learning goals and adapted them to UDL principles, SOLO taxonomy, and Bloom's taxonomy. Bloom's taxonomy helped us with wording the learning goals appropriately and using effective verbs, which are bolded in Table 1. LEARNZ incorporates the SOLO taxonomy by means of "thought bubbles" (Figure 2) on the background pages which are meant to stimulate student inquiry. Figure 4 shows the self-assessment rubric that LEARNZ gives students in order for them to track their learning progress before, during, and after they have participated in a virtual field trip, which follows SOLO taxonomy principles. Our learning goals intended to mirror these stages of learning, but in order to be appropriate for a Tertiary audience, we dealt mostly with the higher levels of learning in both Bloom's and SOLO taxonomy. The learning stages in the rubric are more applicable for Primary and Secondary students. We would expect Tertiary students to be able to start thinking at the extended abstract level at the top of the syllabus in Figure 4. The GEOL 113 workshop focuses specifically on the possible effects of an Alpine Fault rupture on the Franz Josef township since it sits directly on the Alpine Fault. Students are expected to be able to take their knowledge of the Alpine Fault and from this, make conscientious decisions regarding the prioritization of resources. This requires them to think at a higher level of metacognition, which is not quite represented by the original Bloom's taxonomy. Krathwohl (2016) proposes a revised version of Bloom's taxonomy that includes metacognitive knowledge; this requires students to be aware of their own cognition and use that to adapt the ways they apply their knowledge.

We took a trip out to the West Coast with another class from the University of Canterbury – HAZM 401 (Introduction to Hazards and Disasters) – in order to gather some content for background pages including videos and still photos. We used our learning goals in deciding what to film, which is further discussed in the Results section. Filming at these locations also helped us determine which locations would be best to film when the VFT takes place in August.

Existing web material (on the LEARNZ website) from LEARNZ's previous Geohazards field trip also provided a useful reference for preparing learning goals and formatting them into a website. Some material was appropriate enough to be recycled.

RESULTS

By combining both GEOL 113 and LEARNZ's learning goals, we were able to pair each learning goal with a background webpage, as outlined in Table 1. Material for background pages was chosen deliberately based on our evolving learning goals; several drafts were created before we reached a consensus. Each background page also has an interactive activity (i.e. multiple choice questions) associated with it which are meant to engage students with the web material.

For example, part of the goal of the background page on Earthquakes in New Zealand (Figure 5) is to get students to interpret magnitude of shaking and shaking intensity of an Alpine Fault rupture; this is accomplished through the explanation of the Modified Mercalli Scale and an activity that asks students to determine the moment magnitude of an earthquake when given its surface rupture length.

We also used the learning goals as a framework for identifying which places to film on our field trip to the West Coast of New Zealand. Our field trip to the West Coast was meant to give us a chance to film and photograph several relevant locations for this project, which will be used on the background pages. For example, for our first stop in Arthur's Pass, we filmed and photographed the Otira Viaduct because it is a prime example of critical infrastructure that would be affected by an Alpine Fault earthquake. Other locations for filming/photographing included Hokitika, where the Hope Fault meets the Alpine Fault, Gaunt Creek, Harihari, Franz Josef, and the Franz Josef Glacier. As mentioned before, we were able to create a provisional plan for filming the videos for the VFT, at least in terms of identifying key elements that we want to ensure are covered in the VFT.

DISCUSSION

Our overarching goal for this project is to make a successful virtual field trip for the students of GEOL 113 that achieves its learning objectives. Each of the components of a successful VFT (outlined in the introduction) forms an integral part of the LEARNZ VFT experience: the background pages and their accompanying challenging activities help prepare students for the VFT, are quite easy to navigate, and encourage student participation; the learning goals set out clear objectives for students; LEARNZ's Ambassador Programme and "live" aspects foster a feeling of presence/involvement; the LEARNZ website offers access to multimedia content such as videos, still photos, maps, and audio recordings. However, we still needed to alter some of the aspects of LEARNZ VFTs in order to make them work for Tertiary students. Our learning goals needed to be created with a higher level of understanding that goes beyond the SOLO level of "abstract thought" involving reflection and metacognition. This is particularly important when considering that part of our final learning goal asks that students foster a sense of "social responsibility to help the residents of Franz Josef and the West Coast manage their local hazards." Although this may not be able to be quantitatively assessed, it is nonetheless an important learning goal for GEOL 113.

The "thought bubbles" that LEARNZ uses (discussed in Methods) are appropriate for their audience, and we needed to adapt that for our Tertiary audience. Figure 3 shows an example of a “thought bubble” – similar to the one in Figure 2 – from one of our background pages that deals with the seismicity of the Alpine Fault.

Another aspect that needed a change was the activities on the webpages. LEARNZ activities are usually limited to simple multiple choice questions, but for our VFT, more challenging activities are required. For example, students need to be able to calculate earthquake recurrence intervals and interpret moment magnitude based on fault rupture length.

LEARNZ’s Ambassador Programme allows classes to send a “mascot” (soft toy) out to the location of their field trip, which is meant to create a feeling of presence and connection to the field trip. We decided that a Tertiary student would be a more appropriate substitute for this role, so I will be attending the field trip in August.

LEARNZ also organizes Audioconferences between schools and experts in order to give students a chance to ask questions. We have identified four experts from the University of Canterbury for our VFT, including an instructor and a teaching assistant for GEOL 113. These audioconferences usually last about 40 minutes and consist of two distinct sessions: first students ask their questions orally via phone, and then they ask spontaneous questions using a chat window. We have not yet decided how to modify this for our scheduled lectures. Some possible options include: only having one or two audioconferences instead of one per day, timing them so that they coincide with the lecture times, or asking a group of students to volunteer for this outside of normal lecture times.

Logistically – in terms of adapting the LEARNZ VFT format for a Tertiary class – we have three lectures to work with. We created a draft video schedule based on the template that LEARNZ uses for their field trips. Below is a tentative detailed breakdown of how we plan on structuring the filming and lectures:

DAY 1:

Filming Times	**Lecture Time**	**People**	**Location**	**Content to be Covered**	**Illustrations/Props/Demonstrations/Already filmed video clips**
Sunday 7th- Monday 8th	Tuesday 9th (class at 2pm)	Ideally Tom	Video 1: Gondola overlook ChCh ? Video 2: Overlook somewhere along the drive to West Coast	Geohazards & Seismicity of the Alpine Fault	1: Tectonics of New Zealand figure & map of Alpine Fault Example of multihazard (relating to past rupture) 2: Average interval figure (seismicity of the alpine fault page) Past rupture events map image
Key messages: Distinction between geohazards and multihazards; earthquakes effects are not limited to the shaking we feel, they are often followed by landslides, flooding, etc. Talk about using the Alpine Fault’s seismic record to interpret recurrence interval and probability of occurrence.					

DAY 2:

Filming Time	**Lecture Time**	**People**	**Location**	**Content to be Covered**	**Illustrations/Props/ Demonstrations/Already filmed video clips**
Monday 8th-	Wednesday 10th	Tim Davies	Video 3: Previous rupture site	Earthquakes in New Zealand & Earthquake	3: Geomorphic consequences Length & magnitude image

<table>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Tuesday 9th</td><td>(class at 5pm)</td><td></td><td>(Gaunt Creek)

Video 4: Landslide deposit (Poerua Valley)</td><td>Impacts on the Natural Environment</td><td>4: photos of recent flooding and other pictures of landslide</td></tr>
<tr><td colspan="6">Key messages:
Magnitude of shaking along the Alpine Fault (especially in the case of a future rupture) and surrounding the fault. Talk about flooding evidence and cascading hazards.</td></tr>
</table>

DAY 3:

<table>
<tr><th>Filming Time</th><th>Lecture Time</th><th>People</th><th>Location</th><th>Content to be Covered</th><th>Illustrations/Props/ Demonstrations/Already filmed video clips</th></tr>
<tr><td>Wednesday 10th-Thursday 11th</td><td>Friday 12th (class at 4pm)</td><td>Ali Davies and Chris Raine

Locals</td><td>Video 5: Overlook of Franz Josef township/west coast infrastructure

Video 6: Somewhere in Franz Josef

Video 7: Street</td><td>Earthquake Impacts on the Built Environment & Hazard Management & Mitigation</td><td>Maps of infrastructure (highways, train lines, power lines, etc.)
Video clips

Photos of national/international aid
UC Geology Department’s emergency materials</td></tr>
<tr><td colspan="6">Key messages:
Infrastructure (Arthur’s pass, highways, power lines, etc.); critical industries (dairy farming, mining, tourism); focus on people (interviews)</td></tr>
</table>

We have designed this VFT keeping in mind all of the components that were discussed in the introduction; however, it is worth discussing the potential disadvantages with this kind of field trip. One is that it is always a bit difficult to get Tertiary students to participate in activities that do not directly affect their grade in a class. For this reason, students who choose not to engage with the background material on the webpages may be at a slight disadvantage when the VFT takes place. Another thing worth mentioning in this discussion is that several authors have also identified control as an important factor in creating a successful VFT experience (Woerner 1999, Liaw 2007); however, students in this kind of field trip have limited control of their actions. Although they can interact with web material however they choose, they do not have the same options as students working with “virtual worlds” do.

The research for this project unfortunately does not include measuring the effectiveness of the VFT on Tertiary students; instead, it focuses on creating material for the VFT. Overall, designing this VFT has been a successful process. A future research student will be able to assess the VFT’s effectiveness in a Tertiary classroom setting. It would be interesting to compare these results to the results on the student’s assessment of the workshop. This is also a key part of ensuring the success of a VFT; determining whether or not students retain the knowledge they gain from this VFT can offer new insights to the current pool of knowledge on VFTs.

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I would like to give thanks to Ben Kennedy for his expertise, guidance, enthusiasm, dedication and patience. I would also like to thank Sam Hampton for always being willing to help and for taking the time to drive me out to the West Coast for this project. Thanks to Pete Sommerville and Shelley Hersey at CORE for their cooperation and assistance with this project; none of this would have been possible without them. Thanks also to Tom Wilson and Tim Davies for their valuable input. Special thanks to Anny Sainvil and Maoli Vizcaíno for coming along with me on my trip and helping me however they could.

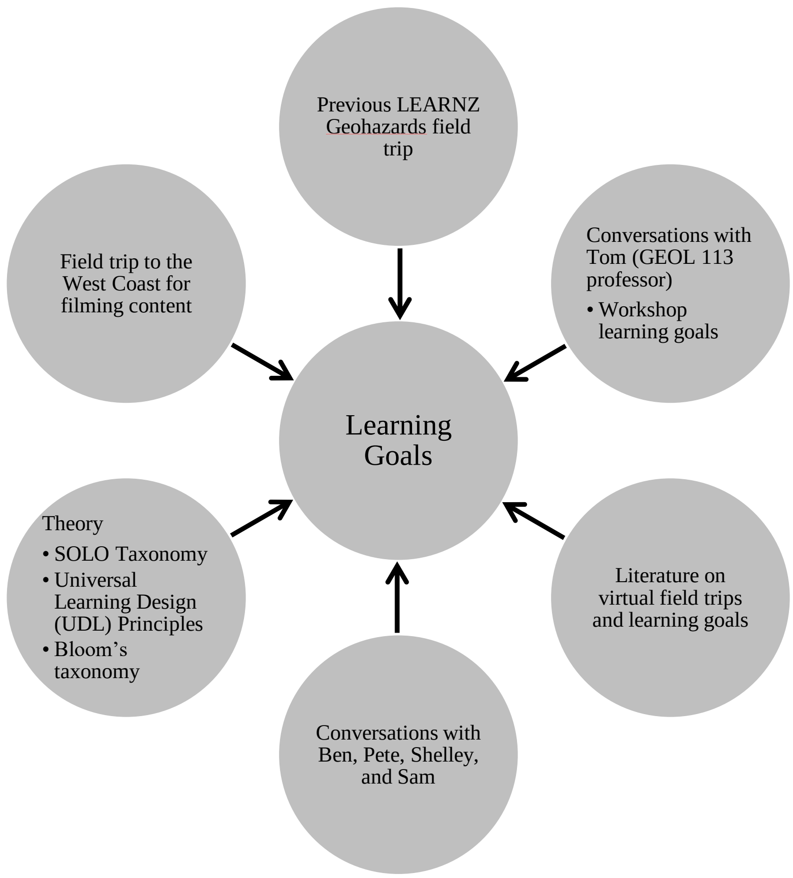


Figure 1: Diagram showing the necessary components for creating learning goals.

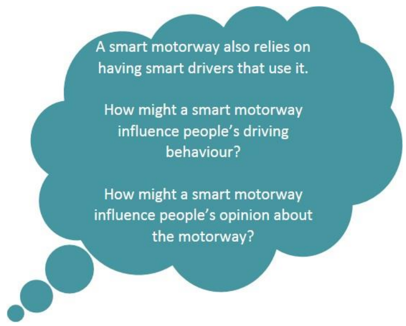


Figure 2: "Thought bubble" that reflects SOLO taxonomy. Image from LEARNZ 2016 Smart Roadways field trip.

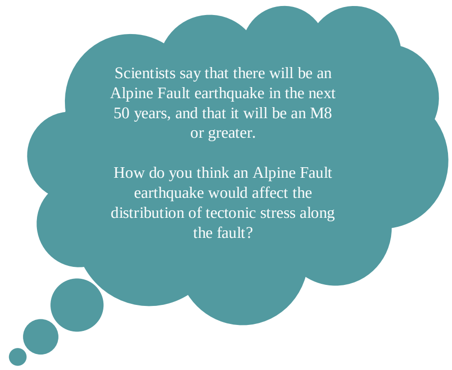
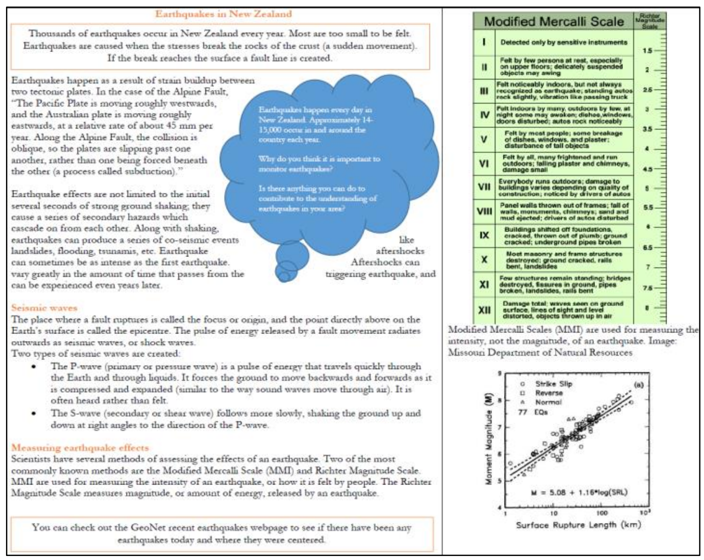


Figure 3: "Thought bubble" from the background page on the Seismicity of the Alpine Fault that reflects SOLO taxonomy.

SOLO	Learning stage
Extended Abstract	I can show others how to find information and link it with examples.
Relational	I can compare facts from the background pages myself AND explain my opinion/s with examples.
Multistructural	I can read the background pages by myself and find some important pieces of information
Unistructural	I can read and find one important piece of information from the background pages
Pre-Structural	I need help to read the background pages

Figure 4: LEARNZ self-assessment rubric for students based on SOLO taxonomy. Image from LEARNZ.


Earthquakes in New Zealand

Thousands of earthquakes occur in New Zealand every year. Most are too small to be felt. Earthquakes are caused when the stresses break the rocks of the crust (a sudden movement). If the break reaches the surface a fault line is created.

Earthquakes happen as a result of strain buildup between two tectonic plates. In the case of the Alpine Fault, "The Pacific Plate is moving roughly westwards, and the Australian plate is moving roughly eastwards, at a relative rate of about 45 mm per year. Along the Alpine Fault, the collision is oblique, so the plates are slipping past one another, rather than one being forced beneath the other (a process called subduction)."

Earthquakes happen every day in New Zealand. Approximately 14-15,000 occur in and around the country each year.

Why do you think it is important to monitor earthquakes?

Is there anything you can do to contribute to the understanding of earthquakes in your area?

Earthquake effects are not limited to the initial several seconds of strong ground shaking; they cause a series of secondary hazards which cascade on from each other. Along with shaking, earthquakes can produce a series of co-seismic events like landslides, flooding, tsunamis, etc. Earthquake aftershocks can sometimes be as intense as the first earthquake. Aftershocks can vary greatly in the amount of time that passes from the triggering earthquake, and can be experienced even years later.

Seismic waves

The place where a fault ruptures is called the focus or origin, and the point directly above on the Earth's surface is called the epicentre. The pulse of energy released by a fault movement radiates outwards as seismic waves, or shock waves.
Two types of seismic waves are created:

- The P-wave (primary or pressure wave) is a pulse of energy that travels quickly through the Earth and through liquids. It forces the ground to move backwards and forwards as it is compressed and expanded (similar to the way sound waves move through air). It is often heard rather than felt.
- The S-wave (secondary or shear wave) follows more slowly, shaking the ground up and down at right angles to the direction of the P-wave.

Measuring earthquake effects

Scientists have several methods of assessing the effects of an earthquake. Two of the most commonly known methods are the Modified Mercalli Scale (MMI) and Richter Magnitude Scale. MMI are used for measuring the intensity of an earthquake, or how it is felt by people. The Richter Magnitude Scale measures magnitude, or amount of energy, released by an earthquake.

You can check out the GeoNet recent earthquakes webpage to see if there have been any earthquakes today and where they were centered.

Modified Mercalli Scales (MMI) are used for measuring the intensity, not the magnitude, of an earthquake. Image: Missouri Department of Natural Resources

Figure 5: Draft webpage on Earthquakes in New Zealand.

Learning goal	Background page
Identify major geohazards and cascading multihazards in New Zealand, with special attention to the West Coast and Franz Josef.	Geohazards
Observe fault scarps in the landscape to **estimate** the fault rupture length, and from this **interpret** the magnitude of shaking and the likely shaking intensity on the West Coast, and specifically in Franz Josef.	Earthquakes in New Zealand
Use the paleo-seismic record to **interpret** how often the Alpine Fault ruptures and from this, **estimate** the likelihood of a future earthquake.	Seismicity of the Alpine Fault
Observe old landslide deposits, unstable slopes, and flooding evidence at Franz Josef and the West Coast to **assess** the cascading hazards associated with Alpine Fault.	Earthquake Impacts on the Natural Environment
Estimate the likely impacts to buildings, critical infrastructure (e.g. roads, power supply, water supply, wastewater, etc.) and people in New Zealand, with special attention to the West Coast and Franz Josef.	Earthquake Impacts on the Built Environment

Identify and **prioritize** resources for managing the impacts of the multi-hazards associated with an Alpine Fault earthquake in New Zealand, the West Coast, and Franz Josef. **Foster** social responsibility to help the residents of Franz Joseph and the West Coast manage their local hazards.	Hazard Management and Mitigation

Table 1: Learning goals and their corresponding background pages.

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