Virtual vs. Physical Field Experience in the Mangatepopo Valley

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Abstract

Virtual field experiences (VFEs) have a growing presence in the classroom as accessible, affordable, and relevant tools to mimic actual field trips. To assess the feasibility of replacing actual field trips with virtual ones, direct comparisons were made between learning goals. A Virtual Field trip to the Mangatepopo Valley in New Zealand was created using Google Earth to mimic an actual field trip to map lava flows in the same area. Geology students had completed lava flow maps in the Mangatepopo Valley that were graded. The same marking scheme was used to grade a group of volunteer geology students who used the VFE to complete the same assignment. The raw data shows a large disparity in grade received; the actual field trip students scored significantly higher than the students who used the VFE. Two students who completed the physical field exercise over three months earlier also completed the exercise using the VFE and scored just as well as they had after being in the field. These students also used the two full hours allotted to them to complete the assignment using the VFE, while other geology students generally used only half the allotted time. Plotting the grade received vs. time spent on the assignment suggests that the full 2 hours of time is needed to make complete use of the VFE. Ultimately, incentives and context matter when asking students to complete an assignment, virtual or otherwise. Considering this, it is plausible that VFEs could be excellent as preparation or reinforcement for an actual field trip, and with ample background information and academic incentives, has potential to act as an alternative to a physical field trip.

Key Words: Virtual field trip, geology, lab class, geo-education

Introduction

In geo-education, field work has a very important place in the learning experience (Fuller et. Al., 2006). Since going into the field for field trips is not always accessible to geology students, it would be beneficial for students to have access to a virtual field experience (VFE), but only if the VFE can achieve similar learning outcomes (Woerner, 2006). Maskall and Stokes (2008) emphasize that the ‘field’ is any place where learning occurs outside the traditional 4-walled classroom and that ‘fieldwork’ is the different activities that are educational and lend themselves to completing the “learning task” assigned to students. Lonergan and Andresen (1988) specify the limitations of “field” applying only to a “greenfield” and suggest that field-based learning is actually more wide-spread than people would commonly believe. A field trip clarifies something that was taught in the classroom, and a virtual field trip would easily fall under this definition. However, it is rare to find a paper touting a VFE as identical to a regular field trip, and the VFE is so often emphasized only as a preparation for time in the field or as a tactic for beginner geology students (Spicer and Stratford, 2001; Maskall and Stokes, 2009; Woerner, 1999). This is not to belittle the importance of catering to introductory geology students, but rather to suggest that the potential for a VFE is greater than it is given credit for. Given the increasing amount of Information Technology (IT) in the classroom, there is enormous potential to expand the field to students and make VFEs a worthwhile, meaningful experience (Warburton et. al., 1997). This investigation found that IT provided an ordered and systematic way to present new information in a way that minimizes distracting novelties present in a new field area. While VFEs have been used on their own, little work has been done to actively compare their learning outcomes with those of an identical assignment done after fieldwork. This direct comparison would provide valuable insight into the learning process and requirements that would make a VFE and an actual field trip nearly interchangeable with the achieved learning outcomes.

Methods

The VFE was created as a meaningful, edging on "real-world" experience using criteria from physical field trips as well as virtual field trips of previous studies. Google Earth was used to create a virtual field trip (VFT) in the Mangatepopo Valley on the North Island in New Zealand (Figure 5, Appendix I). Geology students (300-level) at the University of Canterbury in Christchurch had recently completed an exercise mapping the lava flows in the actual field area, providing a data set for comparison. Using the places where the students stopped in the field (the author participated in the field trip, and GPS points were recorded), photos and videos and some lava flows were marked on a Google Earth kmz file that aimed to provide all of the information students would have received in the field. This included pictures of the landscape, rock samples, marker beds, and instructional videos. A group of ten geology students at the 300-400 level volunteered to complete the same mapping exercise using the virtual field trip. Both groups completed the exercise using an aerial photograph and mylar; the mapping was all done by hand. Students were informally interviewed following completion of the exercise. Both map sets were graded using the same criteria (see appendix for Marking Key). Data was analyzed using Microsoft Excel and Wolfram Alpha.

Data and Results

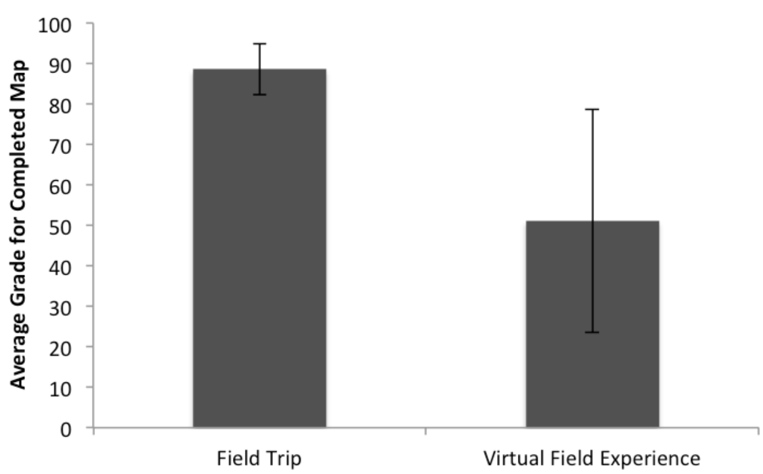

Figure 1. Average total grade for completed maps from students who participated in the Mangatepopo Valley physical Field Trip vs. the students who used and completed the VFE. Standard deviations for each sample population are shown.

The students who completed the virtual field trip scored significantly lower (TTest, $p=9.819*10^{-4}$) on the assignment (51%±27, n=10) than students who participated in the actual field trip (88%±6, n=27).

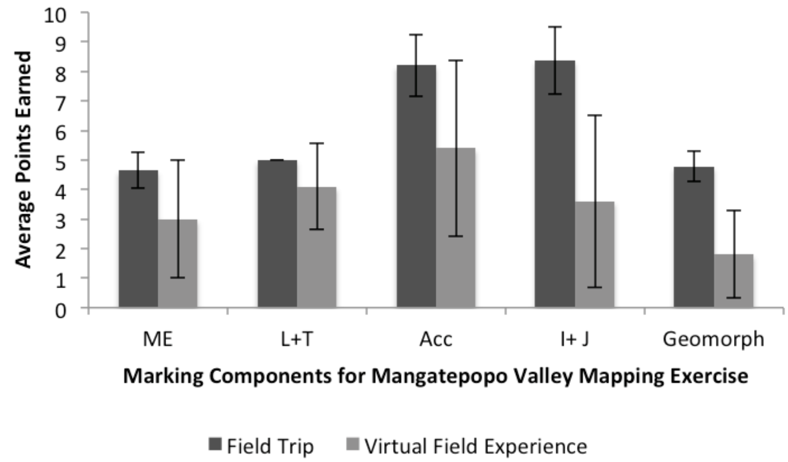

Figure 2. Average marking components for students who completed the mapping exercise in the physical Field Trip vs. Virtual Field Experience. Standard deviations for each sample population are shown. See Appendix I for Marking Key.

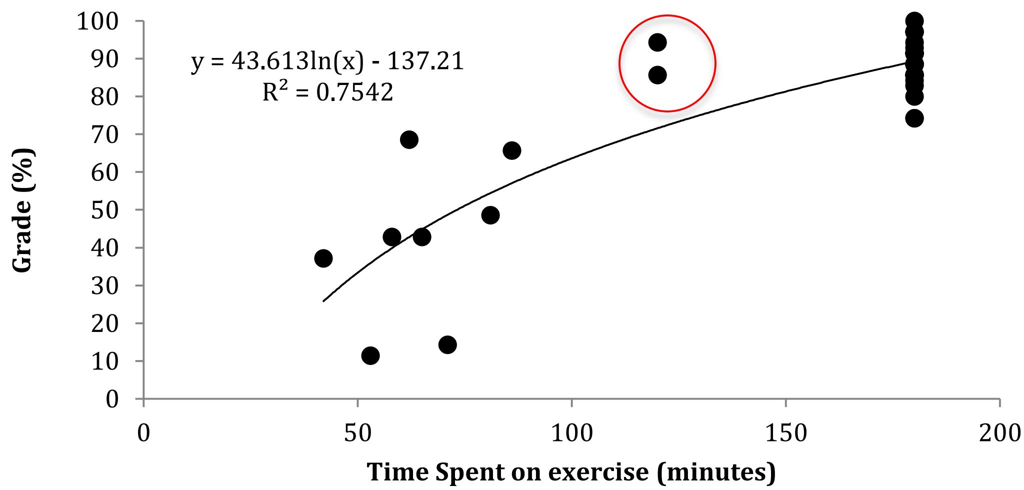

Figure 3. Time spent on the mapping exercise and grade received. Time for students who participated in the actual field trip were assumed to have spent ≥180 minutes. The time when the recording began for the interviews was used to calculate time spent by students who used the VFE.

Students did not score significantly differently between most categories accounted for in the marking scheme. The most significant differences were in the Interpretation and Justification (I+ J) category where the Field Trip students scored an average of 8±1 vs. the VFE students who scored 3.6±3 out of a total of 10 points. None of the other categories had significant differences between the two student groups (See Appendix I for Data). The Geomorph category was also significant where Field Trip students scored an average of 4.7±0.5 vs. the VFE students who scored 1.8±1.5 out of a total of 5 points. The students who used the VFE all stated in the interviews that the experience was helpful and enjoyable. They felt they learned something using Google Earth and getting to map lava flows– a first for the majority of the geology student participants.

Discussion

The students who used the VFE to complete the mapping assignment received lower scores than the students who had participated in the actual field trip. The students who used the VFE were subject to several confounding factors: the students had no incentive to do well on the assignment and the grade did not count into their GPA. Therefore were more inclined to finish hastily and complete the bare minimum. Students in the volcanology class who went to the actual field site had the mapping exercise count for a significant portion of their grade, and had no other assignments or alternative social space besides at the field station. Based on the limited time spent by students on the VFE, and the quality produced during that time, it is likely that had the students spent the full 2-2.5 hours on the mapping exercise, the maps could have mimicked the caliber of work by the physical Mangatepopo valley mapping group (Figure 3). Two of the students who attended the actual field trip four months earlier also completed the mapping exercise using the VFE. Both students produced comparable maps using VFE to the maps produced following the physical field trip. These students also had context for the VFE, and used the full two hours to complete the exercise (Figure 4, Appendix I). This speaks to the importance of scaffolding for problem-based learning. Scaffolding is strategic direction that gives students support for their learning. Simons and Klein (2007) showed that scaffolding supported students in their study to perform at a higher level than students without scaffolds. The students who completed the exercise using the VFE, aside from the two mentioned above, did not have scaffolding available to them. Effective scaffolding may include: a class on the history of the Mangatepopo Valley, how to date lava flows relative to one another, or as part of a volcanology course.

In the interviews, most students enjoyed the actual VFE and found it useful for a broad overview. Some found the VFE well set out, and others found it lacking in detail. The way it was laid out was systematic, and students pointed out that it took away the frustration of being in the field as going back to look at a specific area would not take the hour to hike to as it would in the field, rather it was just a click away.

A debilitating flaw in this study was the lack of context given to the students. These were mainly geo-engineering students who were drawn to do the VFE with free pizza with two free hours of their time. The students were not motivated to give the full effort necessary to receive a good grade, and while the students found the exercise exciting, the quality of work was generally low. Many students even asked for more background information; they were provided with the same introductory readings as the students who completed the actual field trip, yet the volcanology students who participated in the actual field trip were much more immersed in the field of study than these students who were thrown into this VFE without any prior information and knowledge. The students in the VFE did not have an instructor motivating them, and their self-motivation was understandably lacking, alluding to an important conclusion that incentives and context and motivation must be present for successful completion of a VFE.

Simulations provide a bridge between the classroom and the "real world", especially when the "real world" is otherwise inaccessible (Hurst 1998). Schwert et al., (1999) attempted to create a virtual geology trip despite stating the flaw that while a physical field trip engages all five senses, a virtual field trip cannot. If students "learn by doing" then a virtual field trip can be successful. Schwert is adamant that students engage with each other, and because of this, the VFE we created allowed students to discuss and talk as they would during an actual field trip. As students realized this option in the Mangatepopo VFE, they would congregate around one computer, comparing map boards and talking through their maps, much like the students in the physical field trip. One criticism of the VFE was the presenters in the videos were not tailored to a specific audience, and they could not adjust their talk to fit certain questions that students may have wanted resolved. This could potentially be resolved by having an informed teacher present during the VFE to answer questions outside the realm of the videos, or to create more specific videos that would further engage students.

Characteristics of a successful simulation are an "adequate model of the complex real-world situation with which the student interacts (referred to as fidelity or validity), (b) a defined role for each participant, with responsibilities and constraints, (c) a data-rich environment that permits students to execute a range of strategies, from targeted to "shotgun" decision making, and (d) feedback for participant actions in the form of changes in the problem or situation" (Gredler 2004). While these simulation criteria seem focused on a more in-depth VFE, the characteristics are wholly applicable to a smaller-scale VFE. Point "c" is particularly key; students should have enough data that could mimic the thought process and insight of fellow students or professors in the field.

In addition to available data, it is necessary to have very clear, explicit learning objectives for students when teaching using field-based methods (Maskall and Stokes 2008). Lonergan and Andresen (1988) also elaborate on the importance of learning objectives in field-based learning and making sure instructors aid in their students' "noticing". When constructing a VFE, it is important to create points of notice and focus the students into certain areas as a teacher might in the "greenfield". Learning is not as effective when the students are unclear of the educational aims (Gredler 2004). A geologic field trip consists of four key steps: examining the field area to observe and gather data (reconnaissance), constructing a hypothesis about the geology of the area, gathering data specific to test the hypothesis, and analyzing and reporting the results. The study assumes that enough field observations and usable data can be captured in a meaningful way to be accessed on the computer. Vick et al., (1979) emphasized the field observations and interpretations during a field trip in the context of equating the importance of factual knowledge with understanding processes. He outlined key field observations and interpretations that could be converted into a VFE. The students that were interviewed for this experiment were all satisfied with the available data, and only missed the tactile information they could get from a field. This suggests that the VFE can capture much of the data needed for students to successfully complete the assignment, yet the instructor may need to aid with supplemental knowledge for complete understanding of the field area.

Conclusions and Future Work

The mapping exercise completed using VFE in the Mangatepopo Valley demonstrated the potential for the use of virtual field trips in the classroom or lab. Nairn (1999) poses that "superior forms of knowledge are only available to superior bodies" because fieldtrips are geared toward the physically able. A virtual field trip does not discriminate and physical privilege becomes much less relevant than it is during a fieldtrip to a physical location. Since students are not engaging their whole body, they do miss certain social and physical tensions that would be detrimental, but they also disengage from the beneficial aspects of "embodied fieldwork". A successful geology VFE expands remote locations to the entire educational market (Hurst 1998). This includes students of all academic levels that may find travel to these interesting geologic locations impractical and unachievable. The VFE would open doors for these students to real-life examples of textbook geology. Cost, usability, and the fear of technology are the main obstacles in the way of VFE development (Bricken 1991). This may seem counterintuitive as cost would seem lower than a physical field trip. This particular VFE was substantially cheaper than flying students to the North Island to complete the exercise. However, there is enormous energy and human power needed to develop a smooth and enticing VFE initially (Warburton et. al., 1997). This means that a lot of effort has to be put into creating a good VFE; the purpose is lost if the VFE itself is poor and not usable. It would be interesting for a future study to have all students who completed the actual field trip also complete the VFE after four months and see the differences. The VFE should be tested again with students who have been given incentives to do well; ideally their grades would actually count towards their GPA in the class.

Lonergan and Andresen (1988) emphasize the importance of debriefing following a field trip. This is intriguing to think about incorporating into a VFE; the VFE might allow for more time for reflection as the student is working without the physicality of being in the field. Having a knowledgeable instructor in the classroom or laboratory who can provide new information and debrief with the students as they complete the mapping exercise and allowing students to talk to each other is critical for the success of the project. Ultimately, the cost and usability and the real potential of a VFE given incentives cannot be ignored as a powerful asset to the classroom. A VFE should be pursued as both an alternative to physical field trips, a tool for reinforcement, and as a way to deepen students' knowledge of a topic or field area.

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Appendix I

Marking Key for Mangatepopo Valley Mapping Exercise

Map Elements (5) (ME)
North arrow, scale, key, correct title—have they got everything on it? Is it done properly?
Legibility and Tidiness (5) (L+T)
Can you read it? Is it tidy and presentable? Are the contacts legible?
Accuracy (10) (Acc)
Are the contacts right? Are pdc's and lavas marked appropriately?
Interpretation and Justification (10) (I+J)
How correct is it, stratigraphy wise?
Pre-Taupo and Post-Taupo correct?
Small airfall beds correct?
Cross-cutting relationships?
Characteristic properties?
Historic stuff—have you done the reading?
Geomorph/lava features (5) (Geomorph)
Moraines, levees, ogives, cliffs

Table 1. Averages of element and total scores and standard deviations for the physical Field Trip (FT) and the Virtual Field Trip (VFE).

	Total Field Trip	Stdev FT	Total VFE	Stdev VFE
ME (5)	4.6	0.6	3	2
L+T (5)	5	0	4.1	1.4
Acc (10)	8.2	1	5.4	3
I+ J (10)	8.4	1.1	3.6	2.9
Geomorph (5)	4.8	0.5	1.8	1.5
Total (%)	88.6	6.3	51.1	27.6

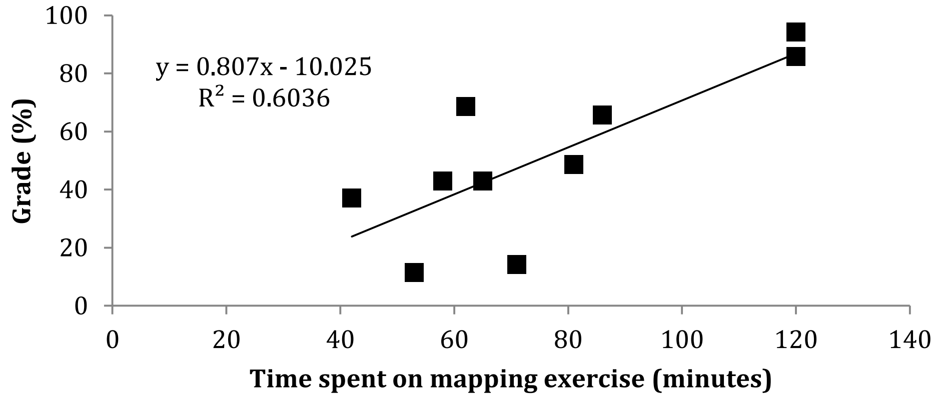

Figure 4. Time students using only the VFE spent on the mapping exercise and grade received. The two highest scorers had competed the mapping exercise four months earlier after the physical field trip.

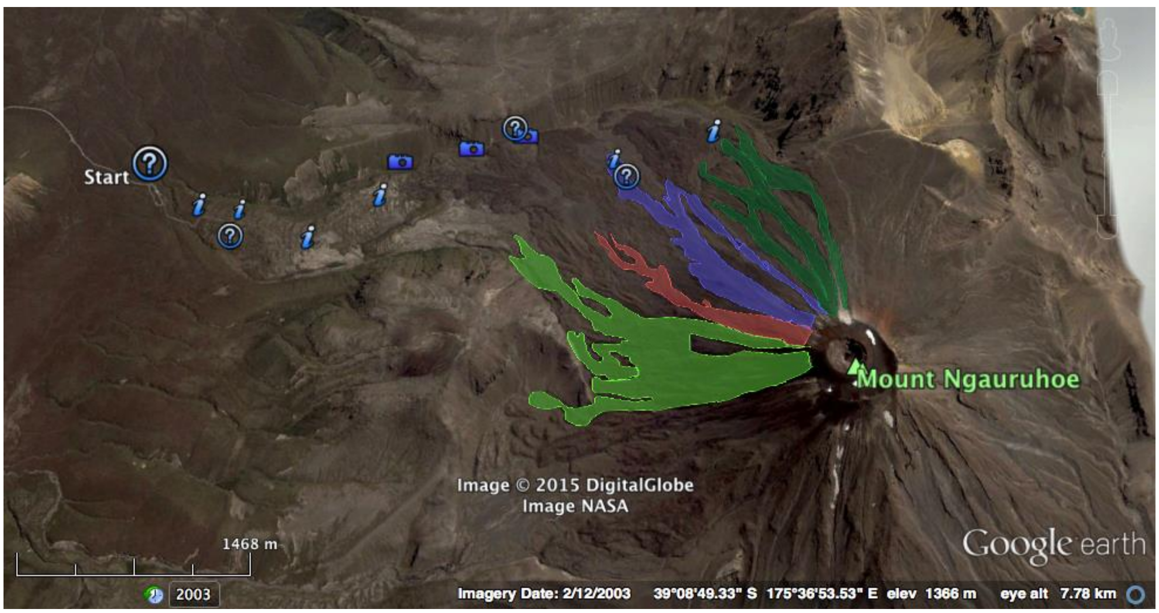

Figure 5. A screenshot of the VFE on Google Earth. Each icon (*i*, ?, camera, or colored lava flow) reveals a pop-up balloon with information when the student clicks on the icon. The student can zoom in and out and adjust viewing perspectives.

References

Bricken, M., 1991. Virtual reality learning environments: potentials and challenges. *ACM SIGGRAPH Computer Graphics*, 25(July), pp.178–184.

Browne, J.D., 2005. Learning Outcomes of Virtual Field Trips used for Geoscience Education. , p.44.

Dohaney, J. et al., 2012. The GeoThermal World Videogame: An authentic, immersive videogame used to teach observation skills needed for Exploration. *New Zealand Geothermal Workshop 2012 Proceedings*, (November), p.7.

Gredler, M.E., 2004. Games and simulations and their relationship to learning. *Handbook of research for educational communications and technology*, (d), pp.571–581.

Hurst, S.D., 1998. Use of "virtual" field trips in teaching introductory geology. *Computers & Geosciences*, 24(7), pp.653–658.

J.I. Spicer & J. Stratford, 2001. Student perceptions of a virtual field trip to replace a real field trip (January) pp.345–354. Available at: http://onlinelibrary.wiley.com/doi/10.1046/j.0266-4909.2001.00191.x/pdf.

Lonergan, N. & Andresen, L.W., 1988. Field-based education, some theoretical considerations. , pp.63–77.

Maskall, J. & Stokes, A., 2009. *Designing Effective Fieldwork for the Environmental and Natural Sciences*,

Nairn, K., 1999. Embodied Fieldwork. *Journal of Geography*, 98(February 2014), pp.272–282.

Nix, R.K., 1999. A Critical Evaluation of Science-Related Virtual Field Trips Available on the World Wide Web. *World Wide Web Internet And Web Information Systems*, p.27.

Schwert, D.P., Slator, B.M. & Saini-Eidukat, B., 1999. A Virtual World for Earth Science Education in Secondary and Post-Secondary Environments: The Geology Explorer. *International Conference on Mathematics/Science Education & Technology*, pp.519–525.

Simons, K.D. & Klein, J.D., 2007. Instructional Science, 35(1), pp.41–72.

Stumpf, R.J., Douglass, J. & Dorn, R.I., 2008. Learning Desert Geomorphology Virtually versus in the Field. *Journal of Geography in Higher Education*, 32(3), pp.387–399.

Vick, T.D. et al., 1979. Field Observations and Interpretations Given New Emphasis. *Journal of Geoscience Education*, 27, pp.15–16. Available at: http://www.nagt.org/nagt/jge/abstracts/1979.html#v27p15.

Warburton, J., Higgit, M. & Barbara, W., 1997. Improving the Preparation for Fieldwork with "IT": preparation tutorials for a remote field class. *Journal of Geography in Higher Education*, 21(3), pp.333–339.

Woerner, J.J., 1999. Virtual Field Trips in the Earth Science Classroom. p.17.