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Instructor Selection And Use Of Virtual Field Experiences In College Geoscience Course

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INSTRUCTOR SELECTION AND USE OF VIRTUAL FIELD EXPERIENCES IN COLLEGE GEOSCIENCE COURSES

Kristen Foley, M.S.

Western Michigan University, 2022

Virtual Field Experiences (VFEs) are a growing supplement and gateway to traditional fieldwork in the geosciences. With VFEs becoming more accepted for use in college geoscience courses, how instructors find and choose VFEs for their students is critical to creating greater accessibility and future resources. VFEs that are not easily accessed by instructors may go unused, and the effort put into making them would have been wasted. This phenomenological descriptive study utilized five focus groups of college geoscience instructors in the United States. Each 1-to-1.5-hour focus group session of 3-7 participants took place on video conferencing software, which was recorded for later transcription and analysis. Findings of this study suggest that instructors consider a wide range of digital resources to be VFEs, such as YouTube videos, gigapans, photos, websites, and open educational resources such as immersive virtual field trips. Results also show that instructors invest significant time to search for and adapt VFEs to meet their course needs because available VFEs, while containing quality content, fail to meet instructors' learning goals. Instructors recognize that VFEs provide opportunities for students who may not otherwise be able to go into the field, and often find the resources they intend to use through their professional networks. Results of this study will help VFE developers understand what instructors want from virtual field experiences, enabling them to better design and market their products. Results will also contribute to a growing understanding of how geoscience instructors find and use VFEs and digital content to adapt traditional fieldwork to online teaching.

INSTRUCTOR SELECTION AND USE OF VIRTUAL FIELD EXPERIENCES IN COLLEGE
GEOSCIENCE COURSES

by
Kristen Foley

A thesis submitted to the Graduate College
in partial fulfillment of the requirements
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This project is dedicated to and in honor of Christopher Petty, geoscience educator and advocate who helped me realize my passion and encouraged me to do all the things. 5/29/91-4/13/20.

Kristen Foley

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INTRODUCTION

Research within the geosciences relies on data from the natural world. As such, direct experience with geologic processes and products outdoors in the field has long been considered fundamental to the preparation of future geoscientists (Dolphin et al., 2019; Mogk & Goodwin, 2012; Petcovic, Stokes, & Caulkins, 2014; Whitmeyer & Dordevic, 2020). With fieldwork historically as a pillar of geoscience education curricula, the field is where students use observations to explore what is known about the Earth and how we know it (Mogk & Goodwin, 2012). Fieldwork is generally agreed to be as an essential component of undergraduate education for a geologist.

Fieldwork, however, is expensive, time-consuming, full of potential for liability, and often a barrier to students who may have circumstances that exclude them from participation in outdoor work (Carabajal et al. 2017; Gilley et al. 2015; de Paz-Álvarez et al. 2022). According to Cawood & Bond (2018), barriers to traditional fieldwork include financial restrictions, differing levels of physical abilities among students, and ease of access to field sites. For example, some field sites are difficult or impossible to physically get to (Carabajal et al., 2017), whereas some sites are located in delicate ecosystems or geoheritage sites (Chan & Kamola 2017). Some field sites are simply impractical to get to with a large undergraduate class or would place a significant financial burden on either the students, the school, or both (i.e., Antarctica, Hawaii, etc.). Carabajal et al. (2017) add to this list the additional time and departmental resources (such as vehicles, equipment, etc.) available. Dolphin et al. (2019) suggest poor weather, access to food, and navigation in difficult terrain can all be barriers to traditional fieldwork as well, as can differences in students' novelty space (Orion & Hofstein 1994).

Rather than bring students to the field, virtual field experiences (VFEs) allow the instructor to bring the field experience to the student. As a result of the challenges of working in the field and advancements in digital technology, VFEs have been growing in popularity in the geoscience community over the past decade (Lei, 2015). Interest in VFEs was further accelerated since 2020 due to the COVID-19 pandemic, which forced many field-based courses to move online. Geoscientists appear to be somewhat divided over the use of VFEs and whether or not they serve the same purposes as authentic outdoor fieldwork. The geoscience community currently perceives no satisfactory replacement for the real-time and first-hand experience that

comes from traditional outdoor fieldwork (Gilley et al. 2015). However, VFEs are perceived as a lower-cost supplement to traditional fieldwork that allows a wider range of students to participate in the field-based aspects of the geosciences (Jacobson et al. 2009).

VFEs fall along a spectrum, ranging from simple to complex with added technology required for operation. On the simpler end of the range, a VFE could include a video or series of photos hosted on a website used to highlight a certain geologic process or locality. On the complex end of the range would be an immersive virtual reality activity implemented into the curriculum. As technology has advanced, VFE applications have evolved from primitive digital photos and static websites to advanced, high-speed, interactive gigapan experiences, videos, and augmented or virtual reality. Similar to the range of VFEs available, how instructors choose to use the VFEs can also be classified on a spectrum, ranging from in-class examples and simple practice exercises to individual or group lab activities and traditional field trip supplements.

Because there is currently no agreement on nomenclature and definitions for digital fieldwork applications in the geoscience community (Foley et al. 2019), the term virtual field experience (VFE) will be used in this document to indicate any computer-based application not used in real time for geoscience education purposes. The term VFE does not include remotely operated digital field technology (e.g., unmanned aerial systems, drones, or submersibles) or technology-assisted fieldwork programs, such as using tablets in the field to map. This term was chosen because the term virtual field experience includes all types of media that add to a complete digital experience of being in the field. Field trips also have specific learning goals and outcomes, while field experiences do not necessarily have any or may be a supporting component of a larger field experience or trip. For the focus groups, I purposefully replaced the term “VFE” with “digital resource” to allow participants the freedom to determine what needed to be included. For example, if a participant used YouTube videos in their course to teach students about the field, they could include it even if they do not consider it to be a virtual field experience. Because of the variability in the literature, I decided to leave the term intentionally vague.

With most VFEs available online, instructors should have the ability to find the right VFE for the topic they are teaching. Some VFEs are available from search engines, while others are hosted by university websites (i.e., vft.asu.edu), company or museum websites (i.e., priweb.org) or instructional resource websites, which can come with an accompanying curricular

guide (i.e., serc.carleton.edu). If instructors know what kind of application they want their students to use, they can look for more specific VFEs from websites like gigapan.com, though more specialized and sophisticated websites can often require a fee to use the available VFEs.

In an ideal world, instructors would be able to easily find every VFE available and rapidly decide how well a VFE may fit with their curriculum. But to date, no studies are reported in the literature that describe how and why instructors find and choose the VFE they will use in their courses. VFE developers can choose to name and market their product as they see fit, therefore some may “fall through the cracks” due to paywalls, unconventional names, or website popularity which can lead to more or less hits online through search engines. As a consequence, VFE developers may not optimally market their products, resulting in some VFE resources going unused. Additionally, if instructors cannot find the resource they need, they may create it themselves or piece together several VFEs to attain the academic rigor they need.

To resolve this knowledge gap, this study uses a focus group methodology to understand how college geoscience instructors search for VFEs online, and how and why they ultimately choose a particular VFE for use in their course. This research will help VFE developers better market their VFEs for more online visibility and use, and contribute to knowledge of what geoscience instructors value in VFEs. Additional benefits to this research include increasing awareness of VFE applications already in existence, exploring the nomenclature base for VFEs, and providing more information about available technology for teaching the geosciences.

LITERATURE REVIEW

What is a VFE?

VFEs are relatively new to the geosciences, and a common nomenclature has not yet been established (e.g., Foley et al. 2019). Elkins & Elkins (2007) call for a “clarification of terminology” (p. 127) because each application and experience is unique. Types of applications used can be either single- or multi-user, and can range in content and social immersion (Carabajal et al. 2017). Table 1 shows examples of terminological variation in the VFE literature, as well as inconsistency in the definitions for each term and how students use each VFE during instruction.

Table 1. Examples of terms related to virtual field trips used in the literature, and author definitions and descriptions.

| Source | Term(s) Used | Definition of Term | Description of Student Activities |
|-------------------------------|--|---|---|
| Mead et al. (2019) | Immersive, interactive virtual field trip (iVFT) | An enhanced type of VFT that incorporates adaptive feedback and offers extensive interactivity | Watch embedded videos and view embedded text as they navigate through a movable series of gigapixel photospheres. Also available are the options to zoom in/out, rotate, and change viewpoints. |
| Dolphin et al. (2019) | Virtual field experience (VFE) | Visual data for a location of geologic interest, to be integrated into a typical lab course | Explore the location, answer questions based on the image data. Develop and practice process skills. |
| Carabajal et al. (2017) | Virtual learning environment (VLE) | To be successful, VLEs must have content engagement and social engagement to allow students to carry out tasks and interact with their surroundings | To be considered a successful VLE, students should have the ability to carry out tasks and engage with the environment |
| | Virtual field trip (VFT) | “a digital representation of or remote access to a field site, real or fictional, through which students engage in learning activities” (p.536) Can include static web tours, single- or multi-user virtual environments, immersive systems, and synchronous or asynchronous remote connections. | Since VFTs represent a range of immersive and interactive qualities, students could be doing anything from looking at a static screen to communicating with people in the field in real-time to using a headset or goggles to interact with and modify the digital environment. |
| Granshaw & Duggan-Haas (2012) | Virtual field environment (VFE) | Digital models of field sites that allow for investigative fieldwork in the simulated world. | Devise and address questions about what they see in the environment. Freedom to navigate the environment and collect data are offered to users. |
| | Virtual field trip (VFT) | The digital equivalent of an instructor talking to students and telling students what they should be seeing; the learning is predetermined. | Listen to the instructor, take notes, ask questions. |

It is difficult to follow the literature with the different terms in use by different authors. Inconsistency in nomenclature can lead to confusion and miscommunication. Defining each of the applications available for literature consistency has yet to happen, but would be beneficial to the geoscience community, particularly to researchers and educators new to this area of geoscience education. Because of the variability in the literature, the term “digital resource” was used during focus groups so participants could draw their own conclusions about what needed to be included. VFE is the term used in this paper because it relates to a broad encounter of any breadth or depth that digitally brings the field to the students.

How VFEs are Used in Geoscience Education

VFEs are available to augment a wide range of learning activities. Some may be used as reasonable accommodations for students with different abilities, while others may be used as entire lessons in and of themselves. Dolphin et al. (2019) make the case for VFEs, pointing out that students have access to explore the locality through images and visual components. One reason Dolphin et al. (2019) gives to use a VFE is that they allow students to take their time with the activity and not rush from one outcrop to the next. Furthermore, VFEs are reusable and cost effective – no vans or equipment to rent, and there are no liability issues to worry about. Carabajal et al. (2017) mention that there must also be social engagement between peers and their instructors mixed with content engagement to make the VFE successful and meaningful for all students. Virtual field learning invites people with different abilities to the geosciences because of its universal design, promoting diversity and inclusion (Atchison & Libarkin 2013; Atchison & Libarkin 2016; Carabajal et al. 2017; Gilley et al. 2015).

However, the geoscience community largely views VFEs as not quite equivalent to authentic outdoor fieldwork (Bryson & Andres, 2020; de Paz-Álvarez et al. 2022). There is yet much work needed for VFEs to be viewed as comparable to traditional field learning and seen as an inclusive and viable option for geoscience learning at all stages (de Paz-Álvarez et al. 2022). For example, VFEs are only as good as the screen they are on – users cannot always zoom in all the way to see grain sizes, and physical tests and measurements cannot always be performed on the rocks (acid test, use a hammer, strike and dip, etc.). Some VFEs can be costly and have additional hardware that needs to be purchased (virtual reality headsets, etc.), such as those offered on immersive.psu.edu. Social engagement is a critical aspect of traditional geoscience

fieldwork that has not yet been reproduced to the same extent in virtual learning environments. The lack of social engagement and poorer learning outcomes in a VFE can cause some instructors to prefer to not use them (Carabajal et al. 2017). It is evident that the commonly accepted learning objectives of traditional fieldwork are centered around making decisions and observations (Bursztyn et al. 2017; Carabajal et al. 2017; Dolphin et al. 2019; Hurst 1998; Lei 2015; Mogk & Goodwin 2012). Virtual field environments have to have different learning objectives, as decisions about what to observe and how to observe it have largely already been made for the student during creation of the VFE (Mogk & Goodwin 2012), such variability is exemplified in table 1. Students are not always free to explore the environment in the same manner that they might on a traditional field trip.

VFEs can be helpful to instructors because they can offer an alternate route to learning goals. Fleming (2022) proposes that Google Earth can be a powerful tool to help scaffold learning, offering that if students start with some prior knowledge, they can better make determinations and interpretations when given a 3D VFE. de Paz-Álvarez et al. (2022) advocate that the virtual field options can be good during a time of crisis, such as the COVID-19 pandemic, but should not be considered a complete replacement for traditional field trips in all cases. Bryson & Andres (2020) agree that VFEs have been a useful tool in recent years but look forward to more bimodal field options for students in the future. Mead et al. (2019) report that students do learn while using the VFEs and suggest that authentic assessments of higher-order learning outcomes can be developed for use within VFEs to more closely mimic those of a traditional field trip.

Unique among the literature reviewed, Granshaw (2019) suggests that students benefit from learning to create their own virtual field experiences. Giving students the tools to create their own VFE can have benefits to the geoscience community by increasing the number of VFEs available, but it should be done with caution to make sure that the information is of good quality and therefore an effective field education tool (Granshaw 2019). The benefits of having students create VFEs could help to set the students up for success by allowing them to be more conscientious of their surroundings and take better care of the work they do in the field since their VFE may be used by others in the future (Granshaw 2019). In creating a VFE, students are given the chance to communicate what they know about science in a new way than they may have been given previously.

Literature Gaps and Research Questions

VFEs have many instructional uses that make them an attractive supplement or alternative to traditional outdoor fieldwork. Students can benefit from moving through VFEs at their own pace and from the opportunity to explore places they would otherwise be unable to visit in person, while departments can benefit from lower costs and reduced liability. VFEs can be difficult for instructors to find and use, however, as many names exist for these applications. While some VFEs are carefully planned and offer students an immersive and interactive environment, others are simpler in nature and therefore do not offer students the same experiences. While there is a great deal of additional gaps in the literature, the gap that this study will focus on revolves around the instructors and their role as VFE users. The research questions this study will seek to answer are:

1. What digital resources (including VFEs) do college geoscience instructors report using in their courses?
2. How and why do college geoscience instructors search for and select VFEs/digital content?
3. How do the instructors choose to implement the VFE in their course(s)?

Because data collection for this study took place in the summer and fall of 2020, my findings are impacted by the COVID-19 pandemic. Instructors had to rapidly shift to online instruction at universities and colleges across the world. The crisis forced many geoscience programs to offer virtual experiences rather than traditional field trips and courses. Although the response to COVID-19 was not an explicit focus of this research, influences of the pandemic frequently came up as focus group participants discussed their experiences rapidly adapting to online learning.

METHODS

Research Design Overview

I have selected a phenomenological, qualitative design for this study because it is the best way to explore and understand the varying needs of instructors and the different roles VFEs can play in their courses. Merriam & Tisdell (2016) describe qualitative research as a way of “understanding how people interpret their experiences, how they construct their worlds, and what

meaning they attribute to their experiences” (p. 6). Qualitative research is also an excellent way to explore a little-known subject or relationship, as this study did. According to Merriam & Tisdell (2016), phenomenology studies the participants’ “conscious experience” and places an emphasis on that experience and interpretation of it (p. 26). I have selected a phenomenological design as the best way to capture the lived experiences of the instructors and their successes and struggles with finding and choosing VFEs.

As a qualitative study, the goal of this research is to understand the subject in great detail (Stake 2010). To achieve this, the study was carried out using five online focus groups of 3-7 people each. Focus groups allow for rich conversations and a reality that is collaboratively produced as described in Millward (2006). This approach aligns with the goals of this study since instructors can compare, discuss, and collectively identify similar successes and struggles when looking for materials to introduce into their courses, especially throughout the COVID-19 pandemic. The focus group design aligns well with the research questions, by allowing for rich and focused discussion to describe the VFE applications selected by instructors, how they were found, and what role they played in geoscience courses. Each focus group is treated as the unit of analysis.

Researcher Positionality

I have previously used several different VFE applications as a student in undergraduate classes. The VFEs were used between 2015 and 2018, mostly as concept-reinforcing activities in online classes. Gigapan VFE applications are my preferred application, however, I recognize that each different type of application is important and useful in its own right. I have done previous research on VFEs and associated technology resources, though primarily to identify nomenclatural differences (Foley et al. 2019). It should also be known that I worked with an independent advisor and take steps in the data analysis (described below) to identify and bracket any biases that came up throughout the research in an effort to maintain research trustworthiness. To do this, we carefully chose terms and verbiage for the focus groups, and considered what may constitute a VFE according to others.

Participant Recruitment and Selection

Participants were recruited through posts on listservs that service the geoscience community (the National Association of Geoscience Teachers, the Geoscience Education

Division of the Geological Society of America, and the American Geophysical Union). Anyone who responded to the invitation and met the qualifications for the study was included as a participant. To qualify, participants must be currently teaching or have taught, within 6 months of the initial recruitment, a geoscience course at a 2- or 4-year college or university in the United States and have utilized a VFE in their course. The study was conducted under an approved WMU HSIRB protocol (Appendix A) and consent to participate was obtained prior to any data collection.

Out of 59 people who submitted the online questionnaire expressing interest in the study, 38 met the initial qualifications and were invited to participate. Of the 38 invited, 23 participants attended focus groups, as described in table 2. In total, 14 of the participants identified as female and 9 identified as male. Seven participants taught at 2-year colleges and 16 taught at 4-year universities. When possible, a mix of 2- and 4- year institution instructors were preferred for each focus group to provide a range of responses and rich data. All participants self-reported their race/ethnicity as being White/Caucasian, and most indicated having intermediate experience with VFEs. Teaching experience in the higher education setting ranged from less than two years to over 11 years. Though the number of participants in each focus group was less than Millward’s (2006) recommendation of 6-12 participants, the data were still saturated following the fifth focus group as ideas became repeated in the later focus groups.

Table 2. Participant demographics

| | | Focus Group 1 N=4 | Focus Group 2 N=6 | Focus Group 3 N=3 | Focus Group 4 N=7 | Focus Group 5 N=3 |
|-----------------------|------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Sex | Male | 2 | 3 | 1 | 1 | 2 |
| | Female | 2 | 3 | 2 | 6 | 1 |
| Ethnicity | White/Caucasian | 4 | 6 | 3 | 7 | 3 |
| Type of Institution | Teach at a 2-year college | 2 | 2 | 0 | 2 | 1 |
| | Teach at a 4-year university | 2 | 4 | 3 | 5 | 2 |
| Teaching Experience | <2 Years | 0 | 0 | 0 | 1 | 1 |
| | 3-5 Years | 0 | 1 | 1 | 1 | 0 |
| | 6-10 Years | 1 | 2 | 0 | 1 | 1 |
| | >11 Years | 3 | 3 | 2 | 4 | 1 |
| Type of Position Held | Instructor | 1 | 0 | 0 | 2 | 3 |
| | Tenure-Track | 0 | 1 | 1 | 1 | 0 |
| | Tenured Faculty | 3 | 5 | 2 | 3 | 0 |

Instrumentation

This study used two sources of data: an online questionnaire and the recorded focus group discussions. The 13-item Qualtrics questionnaire (Appendix B) collected information about participants' teaching experience and comfort level with using technology in their courses. Demographic information was collected through the questionnaire as well as their availability for participation. The focus groups were conducted with a script of 7 open-ended questions (Appendix C), though they were semi-structured to allow for deeper conversation and clarifications. The script was developed based on the research questions and was reviewed to ensure the correct terminology was being used. Prior to data collection, the script and videoconferencing software were pilot tested on a group of peer geoscience education graduate students and committee members with experience using VFEs to ensure that questions were understood as intended and that they would prompt discussion.

Data Collection

Data were collected through focus groups conducted via WebEx online video conferencing software. Each focus group was recorded through the software for transcription and analysis. The duration of each focus group was approximately 1-1.5 hours depending on the number of participants in each group, and how engaged participants were. Millward (2006) recommends that focus groups maintain a duration of less than two hours with adult participants; this study followed this author's recommendation.

Focus groups began with brief introductions of the researcher and all participants, followed by the questions in Appendix C. At the end of the structured time, participants were invited to share anything they thought was relevant to the study that was not directly asked. Many participants took this time to share their frustrations with VFEs and their thoughts about virtual fieldwork moving forward after the COVID-19 pandemic. To promote a natural conversation, I adjusted the scripted questions as needed during the focus groups, for example skipping questions if they were answered indirectly through other conversations. I served as the focus group moderator.

Data Analysis

Data collection was considered complete for this study after the data became saturated, which occurred when there were no new meaningful insights coming from focus groups. After

each focus group, the transcription was analyzed and reviewed to determine whether the script needed to be adjusted. The iteration of data collection and data analysis shows how the two are interrelated, occur simultaneously, and inform one another (Creswell & Poth 2018). This process followed the data analysis spiral suggested by Creswell & Poth (2018).

Final data were analyzed using an emergent coding scheme. On a first pass, common broad themes were identified, and were subdivided on later readings of the transcriptions once all focus groups were complete. Transcriptions were also shared with research group members who helped to identify themes and brainstorm subdivisions for each. The coding scheme went through eight versions before being finalized (Table 3). Revisions were made to the coding scheme because codes were unclear and contributed to an initial low inter-coder agreement score, or codes were not in the right theme. The final iteration of the coding scheme was a result of a reorganization because there was a research question that was not addressed by any of the codes. To remedy this, the codes were paired with each research question and the question was modified to better match the data that were collected. Coding was done with NVIVO software version 1.5.1. In this study, the themes are broad categories that relate to research questions, while the codes are specific categories within each theme that represent data with the same or very similar meaning. During analysis, word clouds were created to display the rough frequency that words were mentioned within a code, though are not quantitative data.

Table 3. Final coding scheme with sample coded text passages. Research question 1 aligns with the “Resources in Use” and “Self-Made” codes. Research question 2 aligns largely with codes in the “Search and Selection” theme, and research question 3 aligns with codes in the “Curricular Use” theme, particularly through the “Course Applications” code.

| Themes and Codes | Description of Code | Example of Text |
|--------------------------------------|--|--|
| Search and Selection | | |
| Satisfied | In reference to searches that result in usable VFEs; positive comments on the search process; and looking for VFEs that meet the needs of an instructor or can be modified slightly to meet their needs. The participant is satisfied with the search process and/or the VFE(s) they found as a result of a search | “I was thinking you know maybe given the crunch that we're under right now maybe I could use that just as-is for something for the students to work through and if I do that it will be the first time that I've actually taken a virtual field trip just the way that it is packaged in actually used that the way it is right now” Focus Group 2 |
| Dissatisfied | In reference to searches that result in unusable VFEs or no VFEs at all; negative comments on the search process; and looking for VFEs that do not meet the needs of an instructor or cannot be modified slightly to meet their needs (learning to measure, strike and dip, mineral and rock ID, etc.). The participant is dissatisfied with the search process and/or the VFE(s) they found as a result of a search. Included are things the participant wishes they had come across but were not found or available. | “Many of them that I find I deem them not sufficient mostly because of the breadth and depth of the material they're displaying is too superficial” Focus Group 2 |
| Websites/Resources/Personal Networks | In reference to specific websites and pages visited to look for VFEs, also included are any other sources used for VFEs that may not be online and person-to-person recommendations that are passed through personal networks | “I think it all starts with our collegial professional organizations and our networking years back I think that's how we started learning about these content” Focus Group 4 |
| Search Terms-Criteria | In reference to specific keywords and search terms used in an effort to find VFEs and related materials online, also included are general search-related statements that explain <i>how</i> an instructor searches for | “I start with I'm thinking about either ‘earthquakes’ might be a keyword that I would use, but it would be ‘how to read a seismogram’ or ‘how-to’ it's always a ‘how-to’ thinking about what I would like to be able to do” Focus Group 1 |

Table 3 - continued

| | | |
|------------------------|---|---|
| | digital content and statements related to what instructors may be looking for in a VFE | |
| Search Motivations | In reference to <i>why</i> instructors search for VFEs and digital resources | “Virtual field trips are really important to us because we have no outcrop” Focus Group 2 |
| Other | In reference to anything related to the search and selection of VFEs that doesn’t fit into the above codes | “I’m for the first time really making more use of virtual field trips that other people have already put together” Focus Group 2 |
| “Making it Fit” | | |
| Time | In reference to time necessary to search for and find a VFE, learn to use a VFE, or modify a VFE to fit curricular needs | “I recognize that an infinite amount of time searching might produce something that's better but we don't have that time and you know our time is so limited as it is” Focus Group 4 |
| Modifications | In reference to the modifications an instructor makes or would like to make in an effort to better match the VFE to the curriculum already in place. Inclusive of elements that are added to, removed from, or changed from the original VFE/resource | “we're going to spend a lot of time making it different and I think the real challenge is in trying to come up with something that is scalable in a good way to people who want something good off the shelf” Focus Group 1 |
| Curricular Use | | |
| Satisfied | In reference to a VFE that does meet the needs of an instructor for their course. The VFE needs little to no modifications to be used in the class. | “The example that I would use as a really good analytical field trip is ASU's field trip of Upheaval Dome and that’s a really fantastic trip that actually engages students gets them to look at the rocks and interpret the rocks and trying to decide whether that's a salt structure or an impact structure so they're actually analyzing rocks through the virtual field trip and try to solve some sort of geological problem” Focus Group 2 |
| Dissatisfied | In reference to a VFE not meeting the needs of an instructor for a given course. The VFE does not meet specific content objectives (learning to measure, strike and dip, mineral and rock ID, etc.) | “The virtual field experience has to be something that involves some sort of some sort of analysis it can't just be a show and tell thing, there's gotta be something that students can analyze and interpret and turn in” Focus Group 2 |

Table 3 - continued

| | | |
|---------------------------|---|---|
| Motivations | In reference to why instructors choose VFEs or certain content within a VFE; specific learning goals and outcomes that motivate a search for particular content or resources; the purpose of using a VFE in the course | “There has to be a purpose to the field trip from a pedagogical standpoint” Focus Group 2 |
| Self-Made | In reference to VFEs and resources that are made by the instructor for personal use or sharing with other instructors | “We made these really crappy videos over the summer like really crappy 'cause the quality was terrible we don't know how to take videos” Focus Group 3 |
| Student Use/Interactivity | In reference to how students use the VFE or digital resource and/or how interactive the VFE is for students. What the student does in the virtual environment, how they manipulate the environment and use it to learn | “Not only is it having narrative but it allows for student interactivity where they can communicate with one another in small groups to try to make sense of things, and it's not just a multiple choice click through answer this to go to the next step but there's actually problem solving and sketching and real-world field geology techniques being implemented” Focus Group 5 |
| Wish List | In reference to the features and content that instructors would like to see included in future VFEs; elements that would make current VFEs/resources “better” but the instructor/user has no way of implementing or including | “Being able to measure and do actual science beyond observational is what I would like to be able to see in the future” Focus Group 5 |
| Course Applications | In reference to how instructors use VFEs in the course curriculum to teach about a topic (more of an “instructor use” category). How the VFE/resource is situated within the course or within the online course materials | “If students missed some of these the field trip labs, I could just assign them the virtual one” Focus Group 5 |
| Resources In Use | In reference to any named digital resource currently used or used in the past. Also included are descriptions of unnamed resources and instances of what currently used resources do and their features | “I use Google Earth and Google Mars or Google Moon” Focus Group 1 |
| Other | In reference to anything related to the curricular use of VFEs that doesn't fit into the above codes | “One thing I've discovered with resources, you always want to check them the night before class because they may suddenly do an upgrade or |

Table 3 - continued

| | | |
|--------------------------------|---|--|
| | | change just as you're about to use something" Focus Group 1 |
| Diversity and Inclusion | | |
| Inclusion | In reference to a VFE being used to include all students and accommodate non-traditional students and those who need other methods of instruction | "There are some students who are served better by this non-traditional format and same with just field camps in general it can be really hard for people to take six weeks off from their home lives to go on to a field camp and so this gives us more flexibility for people who need those other options" Focus Group 3 |
| Accessibility | In reference to the ease and challenges of students being able to access and use the VFE platform via either hardware or software | "When we told them to stay home not to go to the computer labs not to go to the library they said 'I don't have a laptop' or 'I don't have internet'" Focus Group 4 |
| Covid-19 Related | In reference to how VFE use or search criteria have changed as a result of COVID-19. This does not include curriculum changes as a result of the pandemic, or anything in reference to in-person field trips pre-pandemic | "pre-COVID I provided virtual field trips and digital content as active learning activities for content engagement in advance of face-to-face lecture or in advance of an actual field trip" Focus Group 4 |

Validity and Reliability

Validity was established during the focus groups through member checking during the focus group by prompting the group to come to a consensus during the conversation – for example, by asking the participants to confirm that what I am hearing as being a group consensus is correct and looking for participants to nod in agreement or build on previous responses. Following focus groups, I presented the transcriptions to my research group who helped me generate initial themes and potential codes. After coding was done, inter-coder agreement was established as a measure of reliability by having a second researcher (my research advisor) independently code highlighted passages for comparison coding. Calculating an agreement between the two coded documents helped to refine the coding scheme when the score was low, a process that took place three times. The final coding agreement was an 81% match. This process ensured that the codes are understandable and applicable for more than one person.

RESULTS, INTERPRETATIONS, AND DISCUSSION

To learn about the VFEs that are used in college courses across the US, the search process instructors use to find the VFEs must first be examined in detail. These research questions break down the search and selection process and give insights into how the VFEs are used by the instructors to enhance curricular goals. As is common in qualitative research, results are interpreted and discussed as they are reported, using quotes from focus group discussions to support findings. Results and discussion are organized around each research question.

RQ1. What digital resources do college geoscience instructors report using in their courses?

Because the focus group script was intentionally vague about the format and content of VFEs, instructors reported using a wide variety of digital resources in their courses. This proved to be helpful because the participants included some resources that are considered VFEs/VFTs in the literature but are not highly immersive or interactive for students, telling me where they set the bar for VFEs.

The most commonly reported digital resource is the Google Suite, which makes sense given the multitude of things that can be done through this free platform. Instructors reported

the ArcGIS StoryMaps they use as “things created by people using different Maps but you can also include photos, data, things like that and then I lead students through a kind of online lab using those.” Materials on YouTube were reported to be used as enhancements in focus group 5, one participant reported: “I would do little supplemental 6-minute geoscience videos like from David and those folks (YouTube: GeoScience Videos) or “Earth Rocks!” to emphasize what we were doing.”

The states listed in figure 1 refer to either state geological survey resources or university resources. Utah and Arizona have resources that were more frequently reported, though Washington and Nevada offer state geological websites that instructors reported drawing from.

Our state Geological Survey, so the Utah geologic survey, and they have an interactive map that they call Utah Geosites and it provides kind of a map of geologic locations but then each one has kind of a webpage that has additional information on the geology.

(Focus Group 2)

One resource that was named across several focus groups is JMars, which is a GIS mapping program. JMars was highly regarded by participants, one commenting:

One of the simplest and easiest, powerful tools to use is JMars, which is a free Java-based GIS mapping system for planetary bodies. I'll use that for crater counts, for actual making of Maps, it imports all of the available order data as well as having access to ground-based images, so it's a pretty powerful free little tool. (Focus Group 1)

Arizona State University offers iVFTs (interactive, immersive virtual field trips) that were mentioned by participants in several of the focus groups and were often praised for being high-quality and well-rounded experiences for students.

The example that I would use as a really good analytical field trip is ASU's field trip of Upheaval Dome and that's a really fantastic trip that actually engages students gets them to look at the rocks and interpret the rocks and trying to decide whether that's a salt structure or an impact structure, so they're actually analyzing rocks through the virtual field trip and try to solve some sort of geological problem. (Focus Group 2)

Some participants reported using personal photos or resources on personal websites that they found, as seen in figure 1 as the words “website(s),” “photos,” and “video(s)” and explained in focus group 3 that “lots of field photos help you connect your life with the lives of students.” In all focus groups, participants reported creating their own digital activities if they were unsuccessful in finding something suitable for their courses.

RQ2. How and why do college geoscience instructors search for and select VFEs/digital content?

How instructors search for digital content and VFEs online is important to study because with more digital content being created, it becomes harder for users to find to content they want and need. In the case of this study, instructors reported their struggles and successes with finding materials that fit their needs. Instructors also reported what motivated them to seek VFEs for use in their curricula, and how they modified newfound resources to better fit in their courses.

Search Process

Instructors seek VFEs and digital content for a number of different reasons. While some participants raised concerns over a dependance on VFEs, others voiced reasons why they would seek these to begin with. What motivated instructors to search for VFEs to begin with ranged from “I teach entirely online so virtual field trips are important to me” (Focus Group 4) to “virtual field trips are really important to us because we have no outcrop” (Focus Group 2). In these instances, participants chose to use instructional modalities that best fit their courses. Regardless of the motivations participants had for choosing to start a search, there was agreement among participants that the curriculum was central to the search, as evidenced by focus group 1 agreeing that “I’m usually looking for something to fulfill some learning objective,” rather than something that is interesting or new. Across all focus groups, the consensus was that the learning goals should drive the search for particular resources.

When discussing the search for resources, participants seemed quick to agree on where they go as they start the search, as seen in figure 2. The most visited website is SERC, the Science Education Resource Center at Carleton College. SERC’s homepage acts as a search engine for lessons and activities, a place where educators share what works for them. In every focus group, there was at least one participant that named SERC as the first website they visit when they are looking for a new resource, saying “my first stop is generally SERC” (Focus

Group 1) and “I start at SERC always” (Focus Group 3). Within SERC, the InTeGrate and Teach the Earth portals were popular among participants as they narrowed their searches.



Figure 2. Word cloud showing the websites and other resources that participants visit as they start their search for digital content. The more frequently a resource was mentioned, the larger the text appears in the word cloud.

Participants named search engines like Google, as well as state geologic survey websites and online workshops hosted by organizations such as the Geological Society of America and National Association of Geoscience Teachers as common places to find resources they may want to use in their courses. When a participant in focus group 4 shared that “I really appreciate workshops that feel like they deliver impactful information, especially if they give me a chance to practice,” there were others that indicated agreement.

Struggles and Successes

In addition to discussing how they searched for and selected VFEs, participating instructors voiced struggles with finding appropriate VFEs. Despite there being such a wide range of materials available for use, some instructors reported creating their own resources and VFEs. This was reportedly because of either a lack of materials available that fit what the instructor is looking for, or the instructors have something specific in mind from prior experiences that they want to share with the students. A participant from focus group 3 shared the thoughts they have as they struggle to find appropriate digital resources:

This doesn't feel like it quite fits or it's too 'fluffy,' it's intangible or too peripheral, or it's too detailed, to where you're like 'I don't see that as being a useful skill that people are going to need to use.' I'm not going to do it even if it may be really quantitative but kind of arbitrarily complicated.

Other times, VFEs may be well-made but not particularly useful to people in certain localities, “sometimes it's too specific like someone posts curriculum that only works at this one river at this spot and that I find useless because I don't live there” (Focus Group 3). Overall, it seems participants had a clear vision of what they want to find, but they don't always find it. Instructors then must either use something that does not fit well, modify it or puzzle together several resources, or make their own entirely. Participants in focus group 5 agreed “I had a lot of difficulty finding something that was suitable for my needs, and I was getting frustrated with my Google searches and spending way more time on it than I thought I needed to.”

Despite the challenges, some participants reported having successes in their searches, such as this participant from focus group 2:

I was looking at [ASU's iVFT of] Upheaval Dome just like a week ago for the first time and I was thinking you know maybe given the crunch that we're under right now maybe I could use that just as-is for something for the students to work through and if I do that it will be the first time that I've actually taken a virtual field trip just the way that it is packaged in actually used that the way it is right now.

Time and Modifications

An unexpected element that this study brought to the forefront of my attention is the behind-the-scenes effort that instructors give to adapting existing resources to better fit their curriculum. In every focus group, there were participants that brought up how time played a role in how long they searched for resources or how long they spent trying to modify the resource(s) before using them in their course. Participants nodded their heads in agreement and some vocalized their agreement by adding to the discussion about what prior experiences they have with how time creates a barrier to using some resources.

It is clear that instructors' time is precious, as evidenced by participants reporting

I recognize that an infinite amount of time searching might produce something that's better but we don't have that time and you know our time is so limited as it is to be able to devote to developing new activities in a course, especially as an adjunct. (Focus Group 4)

Some instructors reported not only having to take the time to find resources online, but to spend time creating other materials that help to prepare students for using the VFE they've found, one reporting "I've had to take the time to generate an awful lot of instructional video type things" (Focus Group 1). This becomes particularly relevant of a problem when instructors choose to use a resource for something other than it's intended purpose, if it doesn't have clear instructions for use, or if there is a steep learning curve associated with using the resource. "[Students] would not be worrying about the interface, they would not have a learning curve so-to-speak, in a perfect world [there would be] no learning curve if that's even feasible" (Focus Group 4).

If instructors find a resource or two that are good but not quite what they are looking for, the instructor may choose to modify the resources or augment them with additional data or resources.

I think the big takeaway for me is just sort of parsing various digital resources to see how much preparation time is needed, you know they're not all created equal you know some require a little bit more ramp up, gathering data. (Focus Group 1)

Participants in focus group 2 were concerned not only about the data, but about the pedagogy behind the resources:

I never really use anyone's canned virtual field trip I'll use it to maybe be in addition with something that we're going to also do through Google Earth or something else like that, so I'm cobbling together pieces from things that exist mostly because there is no sound pedagogy behind the website with the pictures pasted on it or just doesn't have the depth that I desired.

There is an opportunity for VFE developers to learn about where it is the instructors are looking for resources at and then publish in those areas where they can be more easily found.

RQ3. How do the instructors choose to implement the VFE in their course(s)?

Instructors reported using the digital content and VFEs in a few different ways, though few participants mentioned using them as complete replacements for traditional field trips. Focus group 1 had a discussion on this topic, sharing ideas such as "I was planning on using the virtual

field trips as in-class assignments or homework assignments” and “I implemented them in place of [a] laboratory.” Other groups had similar discussions, sharing that they used VFEs either before or after an outdoor field trip.

We typically have them look at the field area in Google Earth before we go out ... that kind of gives them a feel for the field area before they actually go out and start mapping live in [the] field. (Focus Group 2)

Similarly, focus group 4 included discussions of how to implement the VFE around a field trip:

We have gigapan activities associated with Columbia River basalt features. Before we actually get in the bus and go out and look at the dry falls over by Coulee Dam and the excellent roadcuts of pillow basalts and all that, they have gigapan virtual activities to look at in advance. They can then look at it after the field trip to refresh their memory so they can fill out their journals and that kind of thing for pre- and post-lab activities, that's how I began implementing virtual content like this.

Struggles

Participants reported having some general dissatisfaction with the curricular applications of the VFEs and resources they use. Some from focus group 1 reported being frustrated by publisher resources because “they're too trivialized,” while expressing that they wanted more depth to the activities. Participants from group 5 agreed that students often have trouble with some of the resources:

I found a number of them are over thinking what I'm asking them to do. I give them the exact web address to go to for a virtual sample and once they get there, I want them to use the little video clips and see the still images and they're worried that they have to do everything else and because it's a third-party site. I tell them don't do everything else just use the images and the video clips but you know sometimes it gets lost.

It becomes clear that instructors want depth to the VFEs, but they also recognize that there is such a thing as too much depth for some courses. Some participants showed interest in covering “the basics” for students who are non-majors, such as this participant from focus group 5:

I always have to keep in the back of my mind these are not geology majors so we can't get into you know all kinds of different schistosity orientations and really complicated stuff. We can't get into you know too many different types of sedimentary structure features and things like that. I wanted it to be real simple and you know?

While participants in focus group 3 brought up the important caveat that “hands-on is super important and just making sure that there's not misconceptions that are oversimplified that we're going to poison minds with” that might be included in the resource. Even though students are at an introductory level, that does not mean that instructors should settle for resources that are oversimplified or inadvertently include misconceptions or incorrect information.

The Wish List

Wondering what, if anything would make a VFE better fit into the existing curriculum, participants were asked, barring any financial or technological restrictions, what would make the ideal VFE. Participants offered suggestions of various geological attributes and features, as seen in figure 3, all things that might improve on currently available resources, making them easier to use in their courses. Overwhelmingly, participants in every focus group made it clear that they really want data included with VFEs in the future. Common data that they requested included strike and dip, mineralogy, morphology, and other measurements (or at least the opportunity for students to take measurements), “being able to measure and do actual science beyond observational is what I would like to be able to see in the future” (Focus Group 5).

Geological context for the VFE is important to instructors, as is a sense of scale that students can interact with, “I think [an ideal VFE] would have a different scales aspect so that you could see the regional aspect and then the outcrop and then maybe hand samples from up-close pictures and maybe even thin sections” (Focus Group 2). Instructors want students to be able to zoom out to a more regional scale and then zoom in all the way down to thin section scale. More hand samples and opportunities for students to make their own observations should be included in future VFEs, along with some version of feedback on observations or general guidance for the students, “it would be like ‘read less, do more’ but have some sort of feedback that is given to the students” (Focus Group 2).

Some participants noted that they want students to have an opportunity to struggle with the data and setting, as they would in a traditional field setting, exemplified in focus group 4, “you need to have that uncertainty, you need to have incomplete data and be able to make interpretations.”

A discussion on immersion took place in focus group 5, with participants agreeing that immersion is something to work toward.

[It would] be surround sound, it would have temperature stimulation, it would be haptic so that you'd feel it on your feet or on your hands or whatever part of your body can feel, it wouldn't require that you had legs, OK? 'Cause I have students that roll places, [...] it would be immersive.

Immersion can be, based on this discussion, something that helps the user experience the complete environment. Another participant in focus group 5 commented that “complete immersion is great, I mean, I think that would be fantastic, I think it would be something that could be beneficial for geology majors, students who were going to go on and major in it.”



Figure 3. Word cloud showing what the participants would like to see in future VFEs. The more frequently a resource was mentioned, the larger the text appears in the word cloud.

Emergent Findings

The design of this study and data analysis process left open the possibility that unanticipated findings would emerge from the data. These findings included the importance of

networking when looking for digital resources, and how accessibility and inclusion can benefit from the increased use of VFEs.

Networking

Another unanticipated result of this study highlights the importance of personal and professional networks in finding resources for use in courses. Throughout all five focus groups, participants reported learning about different virtual field resources through their personal networks, either online or in-person. A personal recommendation plays quite a role in the search process for the focus group participants. Some found resources through their teaching assistants, “[the TAs] brought us to some sources that we probably wouldn't have found on our own, based on their own personal research mostly” (Focus Group 3), while others sought the combined expertise of their peers, “we collaborated internally to come up with something” (Focus Group 4).

Focus groups in this study offered a chance for additional collaboration from like-minded individuals in similar situations. Participants reported that “I'm really interested in learning from you all ... the more we share, the better” (Focus Group 2) and “I was hoping that in the group like this I might be able to make some network connections with people who could help out” (Focus Group 5). Throughout each group, I saw at least a few participants taking notes or jotting ideas down, adding to their available resources.

Resources sometimes were reported to have been learned about through the professional network of colleagues and conferences. When one person in focus group 4 suggested that “I learned about gigapan and Google Earth from our structural geologist who had actually been to I think Google sponsored a workshop or an in-person conference to teach people about Google Earth and so he then brought that back to the rest of us who adopted it,” others in the group nodded in agreement. This demonstrates how easy it can be to share resources and train colleagues on their use. Participants from focus group 5 had similar experiences of finding resources through conferences, saying:

About four years ago the geoscience community first started putting out some photogrammetric models and I kind of went from there. That led to going to the Earth Educators Rendezvous and in-person networking with the small groups of folks that were

starting to do this, which has then branched out to GSA meetings and GSA presentations and so there's kind of a small network of folks who are doing this content creator and creating and that's where I've looked into so that I don't have to do too much Google searching or anything like that because it's more of a personal connection.

Even though there were different ways of sharing the resources, participants overwhelmingly agreed that the search process is heavily impacted by their networks.

Participants in focus group 4 echoed each other about how they leverage their networks in the beginnings of their search process. “I think it all starts with our collegial professional organizations and our networking years back I think that's how we started learning about the content,” and continuing with “I think it how we found out about them goes back to what professional networks we work with and how we learn a lot of information that way.”

All of this emphasis that has been placed on networks, it emphasizes how important it is to meet people from different disciplines and specialties because you never know when you might need to call on them for a resource or learn from them how to use a digital tool. Additionally, it is apparent that networks can range from colleagues at a person’s institution to instructors and professionals across the country and world who come together at conferences and in professional societies.

Accessibility and Inclusion

All 5 focus groups discussed the topic of accessibility and inclusion. As they search for materials and use them in their courses, instructors are keeping in mind how easy it will be for students to access the resource and how it can be used to include everyone. Though every participant brought something different to the discussion, there was agreement that the VFEs offer more flexibility for the students to take greater control of their learning. Participants reported non-traditional students and learners who need more time with content being common beneficiaries of the VFEs, saying:

Our student population is a lot of non-traditional students so we either have first-gen, parents, older students, etc. and for those students, especially mothers or parents in general, having the flexibility to be remote or asynchronous they love it and I think they

prefer it and so there are some students who are served better by this non-traditional format. (Focus Group 3)

Participants in Focus Group 3 went on to discuss how beneficial such content can be for learners who just need more time with the material, reporting:

It can be useful because students can take a break when they need a break and come back to it so it offers if you're in the field, if they miss you saying something, it's gone or they miss another student saying something whatever. If they're you know attracted to looking at a bird for a minute and they missed the geology content, they're not getting there, they're just going to miss it and so the virtual environment does allow them to go back and to rewatch things that are confusing and to take a break when they need a break.

One of the unanticipated benefits of remote learning in the past few years has been the flexibility and options that students have been given to take control of their own learning. Though sometimes this has been a distraction or a reason some students get off-track, it can be just what some students need to keep up with the course. As exemplified in the previous quote, one issue with traditional field trips has been that learning happens in real time - if the student misses something, for whatever reason, the content is then gone creating a knowledge gap and a disadvantage for that student. There are a number of things that prevent a student from learning in the field, but these instructors agreed that VFEs can help to solve this problem.

Once a good VFE has been found by an instructor, students need access to technology (reliable internet connections, adequate computers, and appropriate software) in order to use it. Several focus groups discussed how inequitable access to technology impacts student use of VFEs. For example, the internet at the school may be insufficient to run the programs:

At our institution one of the problems we run into is if you have all the students on the computers at the same time but the internet at the institution is insufficient and everything is either just such a slow speed for our students to use, so often times I'll have them work at home on these if they have a computer at home or we have to work in groups so the bandwidth is not exceeded. (Focus Group 1)

Instructors also recognized that often, students themselves had inequitable access to technology required to complete the VFE:

When we told them to stay home, not to go to the computer labs, not to go to the library, they said ‘I don't have a laptop’ or ‘I don't have Internet’ and then a lot of people were without power right about same time. (Focus Group 4)

“Right now, students have different access to different devices and have different access to Internet speeds” Focus Group 5

With all the buzz around VFEs and digital media use in courses in recent years, it is imperative to have a sound foundation of hardware and software that can hold up to the job of running the program before deciding to use one in a course.

Summary of Findings

Instructors find the digital resources and VFEs for use in their courses through organization and institution supported websites, such as the SERC repository, though recommendations through personal networks can play a heavy role in resource selection. The resources that are in use range from websites created by other faculty, images and video tours, to more immersive and interactive programs such as JMars and Google Earth. Depending on the type of resource, instructors use them both pre- and post-field trip, for in-class activities and labs, and (especially during COVID-19 restrictions) as replacements for traditional field trips. This clashes with literature that notes the geoscience community currently perceives no satisfactory replacement for the real-time and first-hand experience that comes from traditional outdoor fieldwork (Gilley et al. 2015).

However they are found and implemented, instructors report being overall satisfied with the available resources, but spend time modifying them to better fit into their curriculum, and sometimes choosing to either create their own resources or cobble together several of the resources they've found, often adding data to resources. As the instructors consider the digital content they bring into their courses, the benefits for the students are constantly in the back of their minds. Non-traditional students and students who need learning accommodations can all benefit from having these resources incorporated into the regular curricula, similarly as reported in Carabajal et al. (2017), Gilley et al. (2015), and de Paz-Álvarez et al. (2022).

These research findings fit into the literature by addressing the gap of the lack of studies that describe how and why instructors find and choose the VFE they will use in their courses.

This study shows that if instructors cannot find the resource they need, they create it themselves or piece together several VFEs to attain the academic rigor they need.

LIMITATIONS AND FUTURE WORK

This study is limited due to the nature of the research design, the reliance on written transcripts, and how questions were posed to participants. First, qualitative research, by its nature, does not allow for generalizations of findings to a broader population. Because this study looked at the lived experiences of the focus group participants in their present-day context, it can only reflect the expressed opinions and thoughts of those members. The participants of this study were people who were motivated to volunteer, namely, instructors who already used and had opinions about VFEs. As indicated by their comments, some participants used the focus groups to look for ideas from other instructors about what worked well in other courses. The results of this study are only representative of this population, and not other instructors who do not use VFEs or the geoscience instructor community as a whole. In light of this, I cannot make any definitive statements about why someone chooses to not use a VFE in their class. Furthermore, as previously discussed, the timing of this study shortly after the transition to online teaching in response to COVID-19 must be recognized as a unique context. To address these limitations, future should involve larger samples that include a more diverse population. Future research will also be able to look back at how the COVID-19 pandemic impacted geoscience field learning, rather than only provide a partial picture as this study has.

Second, data analysis used only the written transcripts of each focus group session. Thus, the verbal emphasis or exaggeration of words, physical responses, and nonverbal communication among participants were not recorded. This may have limited the interpretation and coding scheme because I could not go back and see if participants agreed on some passages or if there were other nonverbal cues of agreement or disagreement. Future research could include nonverbal communication in the transcripts or have an analysis of the video-recorded data collection.

In this study, participants were not prompted to define a VFE and instead were invited to broadly discuss digital resources that they use. The topic of VFEs emerged quickly during this discussion and then became the focus of further discussion. This terminology swap was simultaneously hurtful to the study because participants included resources such as course

management software (e.g., Canvas), and often described things that were not VFEs or even digital resources at all, such as using campus hardscapes or socially-distanced in-person field trips. Future research could further study the differences in terminology used by instructors and have them describe what exactly constitutes a virtual field trip. With continued development of digital content, terminology and nomenclature becomes more important so users can search for and find the content they want and need.

In a future study, there is more to learn about VFEs in the geosciences from the people and teams who make them. In doing so, the choices the developers make and why can be explored, as well as how they intend for their VFE products to be used. The results of such a study could help to compare the intended and actual uses of the VFEs available and identify gaps with the intent to make it easier for users to find content and minimize the time instructors would spend modifying the VFEs to better fit their existing curriculum.

IMPLICATIONS FOR GEOSCIENCE EDUCATION

With continued community discussions about what they need, instructors may benefit from having a larger community of like-minded individuals who can share resources throughout the network. Content developers, if able to incorporate some of the needs of instructors, can play a role in a more thorough training for the next generation of geoscientists. In making the courses designed more universally for everyone to benefit, the geosciences may attract more students who may have otherwise not considered the field. With more data incorporated into VFEs and digital resources, instructors can spend less time modifying existing resources, and the resources will be more comparable to traditional field trips. Instructors may find VFEs and digital resources more easily with more complete and comprehensive collections available from professional networks and societies.

CONCLUSIONS

The findings of this study show that instructors at different institutions use common places to search for digital resources. SERC, Google, personal networks and recommendations are commonly used to find VFEs that match instructors' learning goals. Instructors use a wide range of existing digital resources that include VFEs, however these are rarely used without modification and require instructor time to modify or add data for use in their courses. This

suggests that people who develop VFEs have an opportunity to embed these features and to ensure accessibility so that their resources are more easily implemented in courses. Additionally, instructors want VFEs that have more opportunity to engage students in manipulating data in a similar manner to what would be done in a traditional field trip.

With virtual field options being relatively new to the geosciences, it is important to keep in mind that the resources available are still growing and the community as a whole is still adapting to their development and use. Though there are many uses for these resources in geoscience courses, instructors report that they often still lack many of the fundamentals of field education, such as data collection and interpretation opportunities. I am hopeful that with continued work in this area, the gap between what is available now and what instructors are seeking can be closed. Further areas to address are digital geoscience content creators and VFE developers, learning about how they make the decisions they do for their content, and how they intend for it to be used. With all of this in mind, virtual field resources in the geosciences can be improved immensely and the traditional barriers to field education can be addressed and rectified if possible.

APPENDICES

Appendix A

HSIRB Approval Letter

WESTERN MICHIGAN UNIVERSITY



Human Subjects Institutional Review Board

Date: June 4, 2020

To: Heather Petcovic, Principal Investigator
Kristen Foley, Student Investigator for thesis

From: Amy Naugle, Ph.D., Chair

Re: IRB Project Number 20-05-34

This letter will serve as confirmation that your research project titled "Instructor Selection and Use of Virtual Field Experiences in College Geoscience Courses" has been **approved** under the **expedited** category of review by the Western Michigan University Institutional Review Board (IRB). The conditions and duration of this approval are specified in the policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note: This research may **only** be conducted exactly in the form it was approved. You must seek specific board approval for any changes to this project (e.g., *add an investigator, increase number of subjects beyond the number stated in your application, etc.*). Failure to obtain approval for changes will result in a protocol deviation.

In addition, if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the IRB for consultation.

The Board wishes you success in the pursuit of your research goals.

A status report is required on or prior to (no more than 30 days) June 3, 2021 and each year thereafter until closing of the study.

When this study closes, submit the required Final Report found at <https://wmich.edu/research/forms>.

Note: All research data must be kept in a secure location on the WMU campus for at least three (3) years after the study closes.

251 W. Walwood Hall, Kalamazoo, MI 49008-5456
PHONE: (269) 387-8293, FAX: (269) 387-8276

Appendix B

Qualtrics Questionnaire

Welcome message:

Thank you for your interest in our research study entitled *Instructor Selection and Use of Virtual Field Experiences in College Geoscience Courses*. The purpose of this study is to explore how geoscience instructors at 2- and 4-year colleges and universities in the United States search for, decide on, and ultimately use a VFE in their course(s). The survey below asks for information about the type of course(s) you teach and about your background. It will be used to select participants for the focus group sessions. Further information about the study will be emailed to you if you are invited to participate in a focus group session.

If you have any questions or concerns regarding this study, please feel free to contact me. Thank you for your time and consideration,

Kristen Foley

kristen.meade@wmich.edu

Survey:

Do you currently teach, or have you taught in the past 6 months at a 2- or 4- year college or university in the United States?

Yes, at a 2-year college

Yes, at a 4-year university

No, I do not currently teach at either type of institution

No, I teach outside of the United States

[Yes responses continue the survey. No responses route to a screen with the message: “Thank you for your interest in our research study. Unfortunately, you do not meet the criteria to participate, as we are seeking information from current and recent college instructors. We appreciate your time and interest in this work.”]

Are you currently, or were you in the last 6 months, in charge of the curriculum for the course(s) you teach?

Yes

No

Describe the students you typically teach (choose as many as apply)

Undergraduate students, non-majors

Undergraduate students, majors

Graduate students

Describe the level of the course you typically teach (choose as many as apply)

Introductory

Upper-class

Graduate

Describe the format of the course(s) that you teach (choose as many as apply):

Online

On campus

How long have you been teaching at the post-secondary level?

2 years or less

3-5 years

6-10 years

11 years or more

How would you classify your knowledge about using virtual field experiences?

Beginner

Intermediate

Advanced

What is your current position, or the position that you held in the last 6 months?

Graduate Teaching Assistant

Instructor

Tenure-track Faculty

Tenured Faculty

Other: (enter text)

What is your gender?

Male

Female

Prefer to self-describe (enter text)

What is your race? (choose as many as apply)

White/Caucasian

Black/African American

Native American/First Nations

Native Hawaiian/Pacific Islander

Asian/Asian American

Hispanic/Latinx

Other (enter text)

Please indicate when you will be available to join a focus group. If you select more than one time, one will be chosen for you.

(Date 1)

(Date 2)

(Date 3)

(Date 4)

(Date 5)

Please enter your name and email so that we may notify you if you are selected to participate in a focus group session. Not all applicants may be selected, as we have limited spaces in each focus group session. We will contact you with additional information and an invitation to participate in this study no later than two weeks prior to your assigned session if you have been selected.

Name:

Email:

Confirm Email:

Submission message:

Your responses have been recorded. Thank you for your interest in this study!

Appendix C

Focus Group Script

The term VFE has been purposefully left out as to allow participants to include anything they think fits in the category and needs to be included.

- (1) What course(s) do you teach and what type of students typically take your course(s)?
- (2) Tell the group about the digital resources you use in your course to reinforce field concepts.
- (3) How do you know when a digital resource will be good enough for use in your course?
- (4) How do you find these digital resources?
- (5) When do you decide to stop looking for a digital resource?
- (6) How do you implement the application in your course?
- (7) Starting in the spring of 2020, nearly all universities rapidly moved to online and distance instruction in response to COVID-19. Tell the group about how this situation may have impacted your use of digital resources in your geoscience classes.
- (8) Is there anything else you'd like to share that you think is relevant to my study?

Appendix D

Additional Example Codes

Modifications

“I think the big takeaway for me is just sort of parsing various digital resources to see how much preparation time is needed, you know they’re not all created equal you know some require a little bit more ramp up, gathering data, I’ve had to take the time to generate an awful lot of instructional video type things” Focus Group 1

“where I think the challenge comes in is that and you hear this in listening to each of us you know we would each want to do a field trip to a certain place for a different reason And so if you're doing something that is intellectually meaningful and of course you're dealing with, Kristen you’ve got a group of people who are each of us heavily invested in In thinking about how students learn so none of us is gonna grab something off the shelf and say “oh look here’s a trip to the Grand Canyon I'm just gonna plug it in and hope for the best” right (laughter) we're gonna wish that it were different we're going to spend a lot of time making it different and I think the real challenge is in trying to come up with something that is scalable in a good way to people who want something good off the shelf” Focus Group 1

“I never really use anyone’s canned virtual field trip I'll use it to maybe be in addition with something that we’re going to also do through Google Earth or something else like that so I’m cobbling together pieces from things that exist mostly because there is no sound pedagogy behind the website with the pictures pasted on it or just doesn't have the depth that I desired” Focus Group 2

Inclusion

“it can be useful because students can take a break when they need a break and come back to it so it offers if you're in the field if they miss you saying something it's gone or they miss another student saying something whatever there if they're you know attracted to looking at a bird for a minute and they missed the geology content they're not getting there they're just going to miss it and so the virtual environment does allow them to go back and to rewatch things that are confusing and to take a break when they need a break” Focus Group 3

“our student population is a lot of non-traditional students so we either have first Gen, parents, older students, etc. and for those students especially mothers or parents in general having the flexibility to be remote or asynchronous they love it and I think they prefer it and so there are some students who are served better by this non-traditional format and same with just field camps in general it can be really hard for people to take six weeks off from their home lives to go on to a field camp and so this gives us more flexibility for people who need those other options” Focus Group 3

“something I've especially realized is in terms of Accessibility there's really no going back for me something that that my college really focuses on is inclusivity and a lot of these digital type activities are so much more inclusive for students than traditional field based activities not to say

that they should be done at the complete exclusion of traditional modalities but that they really help bring a lot of people together you know there are so many geologists who really never go to the field whether that's because they work in a lab or something else that that's not the this good old boys in the in the field with their Carhartts is not the only way to do geology and so I'm definitely going to keep as much technology and accessibility and inclusivity in my courses I can going forward” Focus Group 4

Networks

“I'm really interested in learning from you all” Focus Group 2

“The more we share the better” Focus Group 2

“The TAs were a great resource too they knew a lot of stuff that the instructors didn't know so we got a lot of help from the TAs and also gave them a lot of responsibility and they really stepped up and did some nice work for us but in terms of digital resources they brought us to some sources that we probably wouldn't have found on our own, based on their own personal research mostly” Focus Group 3

“I think it all starts with our collegial professional organizations and our networking years back I think that's how we started learning about these content” Focus Group 4

“I think it how we found out about them goes back to what professional networks we work with and how we learn a lot of information that way and sticking with that in like my connections with Callan Bentley and Ron the late Ron Schott who is the gigapan guru of geologically related gigapans had I not started a network type relationship with him years ago I would have no knowledge of all that content he created for digital content that can be applied for virtual field trips that's the one thing I would throw out the most is finding out about things through our networks” Focus Group 4

“We collaborated internally to come up with something” Focus Group 4

“I learned about gigapan and Google Earth from our structural geologist who had actually been to I think Google sponsored a workshop or an in-person conference to teach people about Google Earth and so he then brought that back to the rest of us who adopted it” Focus Group 4

“about four years ago the geoscience community first started putting out some photogrammetric models and I kind of went from there that led to go into the Earth Educators Rendezvous and in person networking with the small groups of folks that were starting to do this which is then branched out to GSA meetings and GSA presentations and so there's kind of a small network of folks who are doing this content creator and creating and that's where I've looked into so that I don't have to do too much Google searching or anything like that because it's more of a personal connection of ‘hey how are you guys doing this’ or ‘hey are you doing that’ and working with NAGT as well to create some of those virtual field experiences for their summer camps they did this summer so that's I really haven't done much searching it's more of what are we doing next you know, what can we do next, how can we take this to the next level so that's my experience” Focus Group 5

“I got to admit when I when I answered your invitation on the GSA forum, Kristen, part of my getting involved in this was very selfish to be able to relieve some of my frustration about trying to get to find exactly what I wanted to I was hoping that in the group like this I might be able to make some network connections with people who could help out” Focus Group 5

Time

“I’ve had to take the time to generate an awful lot of instructional video type things” Focus Group 1

“I recognize that an infinite amount of time searching might produce something that's better but we don't have that time and you know our time is so limited as it is to be able to devote to developing new activities in a course especially as an adjunct” Focus Group 4

“I evaluate how much time would I need to teach the students to use the program or software or whatever it is so there's that amount of time investment in class to get them up to speed and you know cross platform problems etc. and the other thing is just how much time I have to master it and so usually I run out of time personally that's a sincere limitation on my ability to be creative” Focus Group 4

“I had a lot of difficulty finding something that was suitable for my needs and I was getting frustrated with my Google searches and spending way more time on it than I thought I needed to” Focus Group 5

Course Applications

“I was planning on using the virtual field trips as in class assignments or homework assignments” Focus Group 1

“When we had to go fully remote, I implemented them in place of laboratory and it was just OK” Focus Group 1

“Much of the resources that I have used have either been embedded as part of the class work and so there was some expansion of the directions” Focus Group 1

“We typically have them look at the field area in Google Earth before we go out, we also have them use some of Rick Allmendinger’s programs stereonet and geo map extractor that map data extractor and that kind of gives them a feel for the field area before they actually go out and start mapping live in field” Focus Group 2

“either they're an expansion on something basic we learned with me not going into detail what they're about to do or see so they're expanding on what is learned or use it as a precursor at the beginning of a new unit just to elicit something about what do they what students what do they things going on here what do you see so it's, I kind of use it either at the beginning or end there's no rhyme or reason to when I do that in a particular unit or what particular unit I should say but either more inquiry or an expansion on what we're learning” Focus Group 2

“pre-COVID I provided virtual field trip digital content as active learning activities for content engagement in advance of face-to-face lecture or in advance of an actual field trip” Focus Group 4

“we have gigapan activities associated with Columbia River basalt features before we actually get in the bus and go out and look at the dry falls over by Coulee Dam and the excellent roadcuts of pillow basalts and all and all that they have gigapan virtual activities to look at this in advance they can then look at it after the field trip to refresh their memory so they can fill out their journals and that kind of thing for pre and post lab activities that's how I began implementing virtual content like this” Focus Group 4

“I have only used things to replace assignments that were field based” Focus Group 4

“I've really tried to incorporate instead of cartoons of imaginary outcrops using gigapan photography to really go to outcrops for them so they can see that it's not as cookie cutter as it's laid out to be you know in many textbooks” Focus Group 4

“Google Earth has some cool cross section tools and maybe what I do is I show them published cross sections and make them answer questions about it rather than constructing their own and does that still offer the same results in terms of learning objectives” Focus Group 4

“If students missed some of these the field trip labs, I could just assign them the virtual one and they could do all these different things with their partners and it was like they hadn't even missed a beat so it you know it was great” Focus Group 5

“I just look for places where I can try to find stories that can be told better by the students experiencing them than just showing them an animation or something like that or if there is an animation, let's put it within the context of Google Earth or something like that so that they can understand the place where this where these forces or whatever is happening. I guess the conclusion is I try to make it as place based as possible” Focus Group 5

Curricular: Dissatisfied

“a lot of YouTube tutorials and videos I find that the students typically because they are engineers and they are parsimonious with their time investment nobody looks at them so it's a it's a waste unfortunately” Focus Group 1

“I generally do not use publisher resources because I often find that they're too trivialized and they frustrate me” Focus Group 1

“The virtual field experience has to be something that involves some sort of some sort of analysis it can't just be a show and tell thing, there's gotta be something that students can analyze and interpret and turn in” Focus Group 2

“I would not take one of those students and say that they could go out and do field work based on virtual field camp. so, they're going to be hindered in their future I think we're going to have a generation of students that really can't do field work” Focus Group 4

“One of the things I'm having struggling with this is for the intro level is getting students to learn how to make observations on rocks virtually and that they tend to just look at an image and then move on to the next and not make any observations and so that is a struggle I have I don't quite know how to make them slow down” Focus Group 4

“I found a number of them are over thinking what I'm asking them to do. I give them the exact web address to go to for a virtual sample and once they get there, I want them to use the little video clips and see the still images and they're worried that they have to do everything else and because it's a third-party site I tell them don't do everything else just use the images and the video clips but you know sometimes it gets lost” Focus Group 5

“I always have to keep in the back of my mind these are not geology majors so we can't get into you know all kinds of different schistosity orientations and really complicated stuff we can't get into you know too many different types of sedimentary structure features and things like that. I wanted it to be real simple and you know” Focus Group 5

“hands-on is super important and just making sure that there's not misconceptions that are oversimplified that we're going to poison minds with” Focus Group 3

Wish List

“we'd also like to build in to more of the assessment you know for any sort of thing is are the students actually thinking about where this is going for them and are they just checking off the boxes” Focus Group 1

“I think it would have different the different scales aspect so that you could see the regional aspect and then the outcrop and then maybe hand samples from up close pictures and maybe even thin sections of the rock from different places, sedimentary structures, fossils, you know things that you could only observe if you went up and put your nose up to the rocks and some of the that you can get from gigapan and then Some of that you might have to go to a macropan or something” Focus Group 2

“It would be nice to have data attached to the site and it could be simple data strike and dip, textures, mineralogy, 'cause there is so much you could do with that kind of data” Focus Group 2

“It would be like kind of read less do more but have some sort of feedback that is given to the students. not necessarily Oh yes this is the correct answer but somehow some sort of guidance in what they're doing depending on you know what they're looking at how they're looking at it some sort of just small feedback to give students some reassurance but again also to guide them to whatever outcome it is that I'm looking for if I'm not necessarily there with them or in a virtual presence with them” Focus Group 2

“Making observations, measurements and analyses like you would in the field” Focus Group 3

“You need to have that uncertainty; you need to have incomplete data and be able to make interpretations you know” Focus Group 4

“How can virtual experiences field or lab experiences teach students to discovery learn on their own and that that might help with that observational dilemma that we all face” Focus Group 4

“If I'm doing an igneous rock field virtual field trip that has got to be able to cover the entire spectrum of samples that they would have in a lab kit which covers all different types of igneous environments on one specific field trip you may not get exposure to all those so that was that was tough” Focus Group 5

“Being able to measure and do actual science beyond observational is what I would like to be able to see in the future” Focus Group 5

“I'd like to make even more virtual field trips so that our students have something to draw on once they've graduated our courses and then once they become teachers then they can take their students on some of these trips as well so that's kind of the big idea is to make things that hold up to posterity but then can also be adapted to various grade levels to tell different stories, that's what I'd like to see” Focus Group 5

Self-Made

“We made these really crappy videos over the summer like really crappy 'cause the quality was terrible we don't know how to take videos and we just showed how we collected the data and showed the field site and what we were looking for in the decision making that we did” Focus Group 3

“I want to make a new assignment with this with Google Earth how should I do that? I don't know” Focus Group 4

“I just search online for things and I come up with a lot of my own content I feel like because I as an adjunct I think I'm just outside of a lot of those professional circles and a lot of those academic circles so for me I found that I'm doing a lot of that sort of digital resource on my own” Focus Group 4

“We tended to think OK how did we do this when we ran field camp two years ago in person you know sort of the old fashioned get-in-the-van way and what were the learning goals that we really wanted to accomplish that needed to stay the same and what were the learning goals that we could shift into a virtual field trip” Focus Group 4

Search: Satisfied

“I was looking at Upheaval Dome just like a week ago for the first time and I was thinking you know maybe given the crunch that we're under right now maybe I could use that just as-is for something for the students to work through and if I do that it will be the first time that I've actually taken a virtual field trip just the way that it is packaged in actually used that the way it is right now” Focus Group 2

“that's what we started with was learning goals so it would in transferring a field camp to a virtual field camp we identify our learning goals and then you know and then how to meet them

rather than how do you take this specific exercise and put it online then and so that that seemed to work really well” Focus Group 4

Search Motivations

“I teach entirely online so virtual field trips are important to me” Focus Group 4

“Virtual field trips are really important to us because we have no outcrop” Focus Group 2

“I'm usually looking for something to fulfill some learning objective” Focus Group 1

“it's all oriented around ok what is it I'm trying to accomplish here?” Focus Group 1

Search: Dissatisfied

“Many of them that I find I deem them not sufficient mostly because of the breadth and depth of the material they're displaying is too superficial” Focus Group 2

“I'm constantly looking for something that probably doesn't exist” Focus Group 2

“This doesn't feel like it quite fits or too fluffy is an intangible or too peripheral or it's too detailed too where you're like I don't see that as being a useful skill that people are going to need to use, I'm not gonna do it even if it may be really quantitative but kind of arbitrarily complicated” Focus Group 3

“Sometimes it's too specific like someone posts curriculum that only works at this one River at this spot and that I find useless because I don't live there” Focus Group 3

“I had a lot of difficulty finding something that was suitable for my needs and I was getting frustrated with my Google searches and spending way more time on it than I thought I needed to” Focus Group 5

Accessibility

“At our institution one of the problems we run into is if you have all the students on the computers at the same time but the internet at the institution is insufficient and everything is either just such a slow speed for our students to use so often times, I'll have them work at home on these if they have a computer at home or we have to work in groups so the bandwidth is not exceeded” Focus Group 1

“When we told them to stay home not to go to the computer labs not to go to the library, they said ‘I don't have a laptop’ or ‘I don't have Internet’ and then a lot of people were without power right about same time” Focus Group 4

“Right now, students have different access to different devices and have different access to Internet speeds” Focus Group 5

Curricular: Satisfied

“I teach I actually teach planetary geology and one of the simplest and easiest things powerful tools to use for that is JMars which is a free Java-based mapping system GIS mapping system for

planetary bodies so I'll use that for crater counts for actual making of Maps for it imports all of the available order data as well as having access to ground-based images so it's a pretty powerful free little tool" Focus Group 1

"The example that I would use as a really good analytical field trip is ASU's field trip of Upheaval Dome and that's a really fantastic trip that actually engages students gets them to look at the rocks and interpret the rocks and trying to decide whether that's a salt structure or an impact structure so they're actually analyzing rocks through the virtual field trip and try to solve some sort of geological problem that's the kind of thing that I was looking for" Focus Group 2

"I knew that Google Earth had the functionality to do what I wanted I also know that many students have used it in other classes or they're already familiar with it also has a lot of overlap with Google Maps that you run on your phone so some of the user interface comes very intuitively to students" Focus Group 4

Curricular Motivations

"There has to be a purpose to the field trip from a pedagogical standpoint" Focus Group 2

"that's a big one for me it's like OK not just going and looking at different sites, it's like how do we use that information to actually do what a scientist in that field would do" Focus Group 2

"By the time you got into those 300 and 400 and 500 level classes where you know the goal of some of the things that you're seeing really you could do some of that research ahead of time online then you could supplement that with some video or some photos and looking at the relationships on Maps and things like that and although I loved some of those field experiences a lot of the objectives really could be achieved online" Focus Group 4

"after having many decades of teaching experience you just get a gut feeling you internalize what is it you want to help align with your objectives for your students but because I go to places like NAGT and SERC Carleton I know that that is a community of educators that are like minded on quality and so at least I know that I'm not filtering through just any random thing that was uploaded into the world wide webs, if you will, and so I take that as having some colleague expertise already there and I think that's a good starting point" Focus Group 5

COVID-19 Related

"Before this remote learning I wouldn't have described anything that I do as a virtual field trip I mean certainly use digital resources to talk about other places and to have students explore but I wouldn't I wouldn't have used that term so I'm trying to wrap my mind about bringing things in that maybe that could use that term to describe but haven't before" Focus Group 3

"pre-COVID I provided virtual field trips and digital content as active learning activities for content engagement in advance of face-to-face lecture or in advance of an actual field trip" Focus Group 4

"We assume students our demographics are tech savvy and I'm trying to teach my colleagues not to use that word anymore they are tech tolerant and all of us have a tech tolerance limit and what

we're seeing now post COVID is everyone's to the edge of that tech tolerance limit I think and just how much can you put into the technology for the learning I think we've hit that limit" Focus Group 4

Resources In Use

"there's also an open-source planetarium program that I've used primarily in the planetary geology program but in other courses as needed it's called Celestia and it's pretty cool it's customizable and with you know some very minimal coding skills you can build your own add-ons" Focus Group 1

"I've been using some of the 3D interactive diagrams in sketchfab for looking at hands samples and that's been really useful" Focus Group 4

"I do something that's maybe more of a field trip kind of thing for using a couple other faculties' website there's a one I really like that does land it's like a landslide and I can't even think of what it is but it sort of starts with the landscape and then zooms in to show the sediment texture and I actually use that in my intro classes to help students understand plastic sediment texture how landslides basically leave huge things and no sorting and no rounding compare that with other things and so it's just a series of pictures but it gives them a sense of place I think at least it gives me a sense of place so a website that's set up to document that at different levels I find that to be pretty useful I've used it for a long time now" Focus Group 1

"I used Google Earth a lot or I would just use Maps on the Google search because the satellite images on Google search Maps have become better and better" Focus Group 2

"I would just use websites, people's websites because a lot of virtual field trips are just pictures with captions and sometimes, we would use the pictures with captions especially if the picture was good which normally, they're not" Focus Group 2

"there's an interface called GIGAmacro which allows you to pull gigapan photography into their platform and you can do a lot of other things with it such as measurements and so forth so that's I've been using" Focus Group 4

"the main resource that I use is through our state Geological Survey so the Utah geologic survey and they have an interactive map that they call Utah Geosites and it provides kind of a map of geologic locations but then each one has kind of a webpage that has Additional information on the geology and past history and they also then have an additional resource that gives information about different geologic time periods and kind of what was the environment in Utah so that's one I use a lot" Focus Group 2

Student Use/Interactivity

"Google Earth has some cool cross section tools and maybe what I do is I show them published cross sections and make them answer questions about it rather than constructing their own and does that still offer the same results in terms of learning objectives" Focus Group 4

“I also use arcgis online for students and with that they're actually able to manipulate the data a little bit and you a little bit of a data analysis” Focus Group 2

“I'm looking for stories that are being told that they have a narrative and that not only is it having a narrative but it allows for student interactivity where they can communicate with one another in small groups to try to make sense of things and it's not just a multiple choice, ‘click through, answer this to go to the next step’ but there's actually problem solving and sketching and real world field geology techniques being implemented as they're doing these different types of field trips so that that's what I'm really looking for” Focus Group 5

“You could have students plot up the data if there's a fold or a cleavage in a bedding and you can have the students think about the metamorphic facies of the outcrop if there's mineralogical data and they could do simple things like that if there was some meaningful way the students could there is a meaningful way you could, and of course I'm only thinking about this from an educational standpoint, link it to students almost going there and collecting that data themselves and coming back to the classroom and utilizing it you would just remove the step of them physically going there and collecting data they still be able to collect the data by observing and annotating it down, they would be able to manipulate if there is such a way to attach data to the process would be great.” Focus Group 2

“I made short video clips, I took a series of photos, and I took samples and so in their team , what they're supposed to do, each person is supposed to describe 1 sample and then come together to think about how to describe that sample, talk about whether or not to annotate the photographs, talk about they might have a two to four minute video clip and they're supposed to identify the smaller portion of that and then the idea is that the teams will meet with me via zoom and then will put that on the web Google Earth to create a virtual field trip. It will only have 4 stops it'll be a fairly rudimentary first pass at this field trip but we're still in the midst of this so we'll see” Focus Group 4

“they're more willing to participate and learn more they can kind of choose your own adventure” Focus Group 5

Search Terms/Criteria

“What I'm really looking for when I try to create these is incorporating all those different aspects so that when they are done, there's really not much difference between somebody that's experienced an in-person field trip versus the virtual they're still coming away and walking away having completed basically the same goals whether in person or virtually” Focus Group 5

“I start with thinking about ‘earthquakes’ might be a keyword that I would use but it would be ‘how to read a seismogram’ or ‘how-to’ it's always a ‘how-to’ thinking about what I would like to be able to do” Focus Group 1

“Isolating the learning goals was critical for us to really see what the components of traditional field trip or traditional field camp were that we wanted to maintain and how could we achieve that and so then we would go out and search for the best available technologies to be able to do that” Focus Group 4

“I like to find something that's a little bit offbeat so that it takes them longer to find answers than it would take them to do it” Focus Group 1

“it’s normally just ‘virtual field trip’ then I'll modify the search by putting a location maybe after the term ‘virtual field trip’” Focus Group 2

“that's what we started with was learning goals so it would, in transferring a field camp to a virtual field camp, we identify our learning goals and then how to meet them rather than how do you take this specific exercise and put it online then and so that that seemed to work really well” Focus Group 4

“On SERC, I’ll search for virtual field trips or field experiences and things like that but a lot of times I get the same results I’d gotten from Google on SERC” Focus Group 2

“I am always kind of looking for is, I mean this has already been mentioned, but that it meets my learning goals and my learning outcomes and then also is easy to use because some of the things out there aren't easy to use or you need to download additional software and also that it's kind of like interesting or like engaging for the students in some way some of the resources I found the first thing they do the learning outcomes they're relatively easy to use but they're kind of boring and not very engaging for the students so there's some additional things” Focus Group 2

“I wanted to be able to give my students something that was place-based something that was super high resolution something that they can then go out and experience themselves if they so choose” Focus Group 5

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