Work in Progress—Designing Virtual Field Environments Closer to Home: Making a VFE of Rock Bridge Memorial State Park

Laura E Speir
Department of Geological Sciences
University of Missouri
Columbia, MO, USA
https://orcid.org/0000-0002-7017-743X

Rúan du Plessis
School of Information Science & Learning Technologies
University of Missouri
Columbia, MO, USA
rd42c@umsystem.edu

Danielle Oprean
School of Information Science & Learning Technologies
University of Missouri
Columbia, MO, USA
http://orcid.org/0000-0001-8052-0791

Sarah M Jacquet
Department of Geological Sciences
University of Missouri
Columbia, MO, USA
http://orcid.org/0000-0001-6673-4929

***Abstract*—Virtual field trips (VFTs) have enabled geology programs otherwise constrained by budgetary and logistics factors to reconnect their students with the field experience. Yet, fundamental issues remain in how VFTs are designed to enhance learning in lieu of or as predecessors to in-person field experiences. In the past year, we have developed a virtual field environment (VFE) to explore the karstic system at Rock Bridge Memorial State Park near Columbia MO, USA. The VFE is designed to enable both students and park visitors to learn how different geological processes have shaped the landscape over millennia or 'Deep Time'. The goal was to consider a rapid design process using a suite of pre-existing tools with a heavy focus on the intended learning goals that would address local geology. Educational platforms used include ThingLink, Articulate Storyline, and learning management systems (specifically Canvas), to present an interactive format promoting student learning and improving upon the inherent limitations afforded by the in-person field trip. Prototype implementation revealed limitations on the integration of assessment into the VFE and has guided further development incorporating other educational platforms. This VFE serves to fill a present void in the virtual scientific educational experiences for the US midcontinent, especially those related to regional geology**

Keywords—Virtual field environment, public engagement, photogrammetry, geology, field trip

I. Introduction

Field education is a fundamental component of many undergraduate geology programs, ranging from short day trips to immersive multi-week courses. Learning in the field is considered to be highly valuable for students, resulting in cognitive gains in critical thinking and higher-order thinking skills, while preparing students for their professional careers [1]–[3]. However, field education is not without limitations. Large class sizes, budgetary constraints, inclement weather, and inaccessible field sites have led to cancellation and discontinuation of field education opportunities. Despite this, it is generally agreed upon that the benefits of field education outweigh the limitations [3]. To address these limitations, many educators have opted to create virtual counterparts to in-person field opportunities [4], affording students a place to digitally practice field techniques, listen to lectures in context, and explore places they could not otherwise visit [5].

The Department of Geological Sciences at the University of Missouri-Columbia has faced similar limitations over the decades when conducting a mandatory field trip to Rock Bridge Memorial State Park (RBMSP) for the introductory geology curriculum. Inclement weather, inaccessible walkways, and global pandemics have ultimately resulted in the field trip being substituted with a traditional lecture or canceled altogether. To counteract this, we have developed a virtual field environment (VFE) of RBMSP to address these complications while allowing for an interactive experience using pre-existing learning tools. Where the in-person field trip follows a linear path and progression of ideas, similar to that we set out to create a self-guided inquiry-based VFE that allowed students to freely navigate through the park. This differs from virtual field trips (VFTs) that replicate the linear nature of in-person field trips [6].

The VFE we have created is designed to meet an enhanced version of the learning objectives from the in-person field trip and replicate the learning experience of exploring the exemplar karstic system hosted within the crinoid-rich limestone of RBMSP. As with the in-person field trip, the VFE ties together important geological processes, including sedimentary depositional environments, paleontology, weathering and erosion, fluvial drainage, and karstic subterranean systems. Our student learning objectives include being able to (i) communicate what a fossil is and their importance to the formation of the host limestone; (ii) relate the underlying geology to the observed topographic features; and (iii) place the major geologic events involved in the formation of RBMSP in chronological order. Both the VFE and in-person field trip provide students with a broader context of the region, both in space and time, by juxtaposing evidence of past paleoenvironments, with present-day land-locked geography to improve student comprehension of landscape evolution in Deep Time. We posit that using a suite of pre-existing tools will enable the developer to more efficiently focus on aligning

Funded by the 2021 Paleontological Society Outreach and Education Grant

higher-order objectives to learner outcomes by reducing overall development time. Additionally, the use of local sites can improve exposure to geology concepts to inform beyond introductory courses and broaden public engagement. Below, we document our process of designing and developing our VFE over the course of one year.

II. Development

Initial scaffolding of the VFE was developed in ThingLink (https://www.ThingLink.com), an online education platform specializing in interactive visual media. This platform hosts a series of 360° photographs from key stops throughout the park, forming the fundamental framework to the VFE. Each stop consists of a series of annotations or 'hot spots', including text descriptions to informational images, and embedded web content. Notably, ThingLink has incorporated Microsoft's Immersive Reader to read aloud and automatically translate all text media within the VFE. In addition to 2D media, specimens of rocks and fossils commonly found within the park in the department's collections were reproduced as 3D models using an in-house photogrammetry set-up.

ThingLink can be embedded into learning management systems (LMSs), however built-in assessments are limited to conditional short answer questions that must be answered correctly to advance through the virtual tour. Data regarding these answers are not stored within ThingLink and cannot be linked to our institutional LMS (Canvas). We deployed an initial prototype of the VFE in Fall 2021 (owing to bad weather), wherein the ThingLink tour was embedded in a Canvas quiz and followed by a summative assessment. Upon opening ThingLink, students arrived on a landing page with a map, list of sites, and legend for 'hot spots' they were encouraged to investigate (Fig. 1A). The tour was unguided, and students could click on sites on the map to navigate to any location and explore, though the assessment was tied directly to certain locations. After selecting a site on the map, they would arrive in a 360° image of that location and 'hot spots' would become visible (Fig. 1B), which would contain information to complete the assessment in Canvas.

In our current version, we are incorporating more contextual guiding information through a narrative. We have utilized Articulate Storyline, an educational platform that can be directly integrated into an LMS. Storyline enables us to provide stealth, formative, and summative assessments (Figs. 1C–D). This enables us to create a more active, constructive, and authentic meaningful online learning experience [7] and allows for higher-order connections that can be lacking within VFEs [8]. By itself, Articulate Storyline is somewhat limited in its interactivity with 360° images, particularly with the functionality of annotations. We opted to embed content from ThingLink to take advantage of the operational diversity afforded by the platform and the assessment capabilities of Articulate Storyline. The combination of the two programs has formed the basis of our suite of pre-existing tools to rapidly develop an interactive VFE that incorporates multiple forms of assessment to accompany different interactive exercises.

III. Outside Significance

The joint venture between interactive technologies and spatial sciences serves to bridge the outdoor world and the classroom forgoing potential barriers imposed by in--person field trips. Several VFTs and VFEs have been developed to highlight geological and paleontological areas of interest across the United States and can be accessed through multiple repositories [9], [10]. However, many specifically showcase geologically complex areas or are associated with select institutions (i.e., museums or colleges). Of those listed within these repositories, none incorporate Missouri geology and paleontology. This gap in VFT/VFE offerings means students are limited to visiting sites that may be unfamiliar to them and exhibit no relation to their regional geology. Particularly for introductory courses, developing a sense of familiarity with 'backyard geology' should help to reinforce learning objectives by connecting knowledge obtained in the VFE to what students see every day in their surroundings. While our VFE addresses the formal educational needs for the Department of Geological Sciences at the University of Missouri-Columbia, it also serves to bridge the geographic gap in representation of VFE offerings across the US midcontinent [9].

Our intention is to further extend the reach of the VFE to broader audiences within the state, in a larger effort to develop formal and non-formal educational resources that engage participants in learning that Earth's surface and inhabitants change through time [11]. This is imperative in fostering scientific literacy of our planet and its resources within our communities. Because open-source VFEs are not limited by geographic location or accessibility, they therefore provide a means of raising awareness with respect to the significance of our State geological and paleontological heritage.

IV. Acknowledgements

This project was funded by the 2021 Paleontological Society Outreach and Education Grant. We would like to thank Jacqueline Sumida for her photogrammetry assistance on this project.

References

[1] American Geological Institute, "The Value of Field Experience: A Consensus of the American Geological Institute (AGI) Geoscience Associates, March 2001 | American Geosciences Institute," 2001. https://www.americangeosciences.org/community/value-of-field-camp (accessed Mar. 07, 2022).

[2] D. W. Mogk and C. Goodwin, "Learning in the field: Synthesis of research on thinking and learning in the geosciences," in Special Paper of the Geological Society of America, vol. 486, Geological Society of America, 2012, pp. 131–163.

[3] H. L. Petcovic, A. Stokes, and J. L. Caulkins, "Geoscientists' perceptions of the value of undergraduate field education," GSA Today, vol. 24, no. 7, pp. 4–10, 2014, doi: 10.1130/GSATG196A.1.

[4] G. Tuthill and E. B. Klemm, "Virtual field trips: Alternatives to actual field trips," Int. J. Instr. Media, vol. 29, no. 4, pp. 453–468, 2002.

[5] A. Klippel et al., "Transforming Earth Science Education Through Immersive Experiences: Delivering on a Long Held Promise," J. Educ. Comput. Res., vol. 57, no. 7, pp. 1745–1771, 2019, doi: 10.1177/0735633119854025.

[6] F. D. Granshaw and D. Duggan-Haas, "Virtual fieldwork in geoscience teacher education: Issues, techniques, and models," in Special Paper of the Geological Society of America, vol. 492, Geological Society of America, 2012, pp. 285–303.

[7] N. Dabbagh, R. M. Marra, and J. L. Howland, Meaningful online learning : integrating strategies, activities, and learning technologies for effective designs, 1st ed. New York, NY: Routledge, 2019.

[8] G. Dolphin, A. Dutchak, B. Karchewski, and J. Cooper, "Virtual field experiences in introductory geology: Addressing a capacity problem, but finding a pedagogical one," J. Geosci. Educ., vol. 67, no. 2, pp. 114–130, Apr. 2019, doi: https://doi.org/10.1080/10899995.2018.1547034.

[9] Earth@Home, "VFE catalog," 2021. https://earthathome.org/vfe/database/#statevfelist (accessed Feb. 28, 2021).

[10] MicroMyEarth, "Virtual Geology Field Trips," 2021. https://micromyearth.com/virtual-field-trips/ (accessed Feb. 28, 2021).

[11] M. H. Henriques and R. Pena dos Reis, "Framing the Palaeontological Heritage Within the Geological Heritage: An Integrative Vision," Geoheritage, vol. 7, no. 3, pp. 249–259, Jan. 2015, doi: 10.1007/s12371-014-0141-9.

Fig 1. A. Screenshot of interactive map on the ThingLink platform B. Screenshot from underneath the rock bridge showing the ThingLink platform. Multiple 'hot spots' are included to provide additional context for students, including information about rock types and formation of the feature, 3D models, and VFE advancements. C. Screenshot from Articulate Storyline showing multiple choice assessment. D. Screenshot from Articulate Storyline showing immediate feedback alternatives depending on response to multiple choice assessment.