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eRock: an integrated, contextualised approach to the use of virtual outcrops for geoscience education

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Geoscience educators and students often find field-based exercises the most effective medium for understanding complex geological concepts and visualizing relationships in 3D. Traditional barriers to field-based training, including physical disabilities, lack of financial resources, and geographical restrictions, mean that this method of training is not available to everyone, however. Recent advances in data acquisition and processing techniques mean that 3D reconstructions of outcrop and landscapes are increasingly used by the geoscience community as a research tool and, more recently, as an accessible means of communicating geoscience within industry and academia. In spite of these developments, little has been done to leverage this technology as a tool to circumvent barriers to physical site access or supplement traditional educational practice in the geosciences. Further, little evidence exists as to the efficacy of these tools for reinforcing and improving understanding of 3D geological structures; potential benefits of virtual outcrop-based teaching methods have, as yet, not been quantitatively assessed in the geoscience education community.

In this study, aimed at participants from a range of educational and professional backgrounds, we assess whether virtual outcrops enhance 3D geological understanding. Through a series of classroom-based and online multiple choice exercises, we compare how effectively virtual outcrops impart 3D geological information, compared to traditional 2D materials such as geological maps and field images. We collect qualitative data on the perceived benefits and pitfalls of virtual outcrops as tools for geoscience education. Results show that virtual outcrops are more effective than traditional teaching materials at conveying geological information: structural geometries and 3D relationships are better understood via virtual outcrops than through the use of oriented field imagery or geological maps alone. Undergraduate respondents also reported an improvement in their perception of 3D landscapes and visualization of complex geological structures after revisiting, in virtual outcrop form, a site where they had previously received field-based training. Finally, we find that across participant cohorts, the use of virtual outcrops for teaching and learning is perceived favourably, with the majority of participants regarding the use of virtual outcrops as a positive, useful technique for communicating geological concepts.

Based on these results, we suggest that digital realisations of outcrops can improve 3D understanding of complex geological structures, irrespective of user background or education level. Participant feedback, however, highlights the need for contextualisation of virtual outcrops if they are to be an effective tool for education. Supplementary materials should be provided so that students can understand the scale of the object they are looking at, its geological significance, and how it relates to the surrounding landscape and subsurface. eRock (www.e-rock.co.uk), our online repository of virtual outcrops and hand specimens in 3D, takes this approach: virtual outcrops are provided as part of a suite of educational materials, including geological maps, cross sections, field photographs, and text. Our results show that virtual outcrops can be effective teaching tools - eRock aims to provide the necessary context to make these a useful teaching tool for the geoscience education community.