EGU21-3581
https://doi.org/10.5194/egusphere-egu21-3581
EGU General Assembly 2021

A blended learning approach to structural field mapping: combining local geology, virtual geology, and web-based tools

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In September 2020, the Corona crisis offered us an opportunity to develop and test a blended real and virtual interdisciplinary field mapping class, as well as revealing the need for, and stimulating development of new web-based tools for structural interpretation.

Universität Mainz' usual Master's advanced field mapping, and Universität Tübingen's usual Bachelor's mapping classes were replaced with combinations of (i) virtual field mapping of Jurassic-Cretaceous sedimentary units at Molinos, Teruel Province, Spain, and (ii) field mapping of metamorphic rocks in the Mittelrhein Gorge and the Arh Valley, and outcrops of sedimentary rocks near Tübingen, Germany, which the students were mostly able to access on day trips using public transport or by bicycle.

For the Molinos part of the exercise both groups were offered hand specimens containing distinctive fossils, linked to locations (and pseudo-locations) by google .kmz files, a variety of structural measurements also linked via .kmz files, and detailed satellite imagery within which mappable geological units display distinct characteristics. Introductions to the stratigraphy were made in three virtual outcrop sections examined in Google Street View from within Google Earth, and via web-based photogrammetric 3D outcrop models made available on the V3Geo virtual 3D geoscience platform. The students then extrapolated this stratigraphy based on the satellite imagery and .kmz file information.

Our perception, validated by student feedback, is that the real parts of both field excursions were very important since they allowed us to teach and refine mapping and compass methodology and best demonstrate how to analyze 3D geometries of geological structures. Universität Mainz students particularly benefited from being able to visit locations where we had already made 3D outcrop models and offered a digital excursion, in the Ahr Valley (Rhenish Massif). They were able to compare real structural measurements with those derived from the precisely georeferenced 3D models, which enhanced their ability to subsequently obtain such information solely from the models. Although final student maps were of comparable quality to those produced in the field,

structural interpretations were hampered by a lack of field measurements. In many cases, the Google Earth DEM is of too low resolution and ways should be found to include higher-resolution DEMs in web-based data sets.

Overall, we think there were advantages compared to traditional field mapping, such as (i) enhanced evidence that methods like ‘structure contouring’ were used in all mapping, (ii) we were stimulated to teach the students to use digital methods to acquire field data, such as StraboSpot and Stereonet11 Apps. We observed these tools, and others we were unaware of, being used in combination with traditional paper and compass during the real mapping exercise. We hope to continue to employ this blended teaching approach even when the Corona crisis passes. This will be facilitated by our development of further 3D outcrop models, .kmz files with key information about outcrops in the Mittelrhein, and especially, web-based (rather than PC-based) tools to extract structural data such as plane and line orientations from 3D outcrop models and enable collaborative work on one data set.