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Beyond Maps - the use of Highly Immersive Visualization Environment (HIVE) technology in using VR and AR in geoscience education

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Abstract:

The Highly Immersive Visualisation Environment (HIVE) is equipped with a two-channel tracked ActiveWall (8m x 2m) and a variety of software for panoramic and virtual tours, spatial, seismic, reservoir estimation, mining, and structural modelling in combination with advanced 3D projection and high-performance computing facilities. These capabilities make the HIVE a truly unique tool suitable for data modelling, management, and analysis. The HIVE's stereoscopic 3D capabilities allow for exceptional data visualization and interpretation through various modelling techniques. The system's 3D projection, motion tracking, and alternating glasses provide an immersive experience for users to demonstrate specific items such as digital elevation models (DEM) and other types of spatial data. The HIVE is also capable of displaying parallax-based stereographic images using either special alternating glasses or anaglyphic glasses. The advantage of using a HIVE, as compared to other 3D visualization systems, is that the rendition of the images is as immersive as the usage of 3D-goggles but available to all participants in the viewing room at once as opposed to individuals using their own 3D goggles.

The HIVE system has been used to prepare first-year students in Geology for their field-based training of their degree programme. Due to the COVID-19 pandemic and social distancing regulations, virtual tools were used to illustrate some of the features taught in class. Results obtained from reflective questions completed after the use of the virtual tours presented valuable information on how to improve the virtual tours. Some of the suggestions made were to provide more video explanations for the various outcrop or geological feature stops and use more overlays and explanatory texts.

Post-COVID-19 pandemic, virtual field trips (VFTs) were enhanced using various tools to create them. Google Earth images were used for expert-novice contrast to build the initial virtual tours. The 360^0 landing images of the field areas were enhanced with high-resolution imagery of critical details to observe as well as explanatory notes and overlays to indicate key features to look out for. High-resolution videos and still images from a drone were added to improve the spatial realization of the magnitude of the geological features of interest. Exposing students in advance to characteristic features they will be observing in the field using these VFTs helped them know what to look for and "hit the ground running." By making the VFTs available on the University's digital instructional platform (iKamva) for a week prior to the excursion, students were allowed to familiarize themselves with the features they would be exposed to during the field trip.

The learning gain of 109 students because of these VFTs was analysed using the Paired Samples t-Test where average scores of eleven pre- and post-VFT questions were compared. The paired samples t-test for a class of 109 first-year geology students showed that participants' level of understanding of the 11 different geological concepts assessed increased from pre-VFT ($M = 4.71$, $SD = 1.94$) to post-VFT ($M = 7.06$, $SD = 3.20$; $t = 6.67$, $p = 0.00$, $d = 0.64$) with a pooled standard deviation of 3.68 for the pair. The paired samples t-test is a statistical test that determines whether the mean change for these pairs is significantly different from zero. In this case, the null hypothesis was rejected, meaning that the 2.35 mean differential in the total scores is a 49.9% increase in average score of the post-VFT assessment and was not due to chance variation ($p < 0.05$). The standardized effect size of the mean difference (Cohen's d) can be considered as a signal-to-noise ratio (mean differential = signal and pooled variability = noise). The Cohen's d value of 0.64 for this work indicated a medium effect size.

These results indicate that preparation of this nature for a real field excursion does indeed prepare students better for the real-life experience.

Future research may focus on building real-life environments using AR/VR and gaming software.

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