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Geoscience educational e-gaming to provide stimulating & effective learning

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Abstract
Most current HE students will have grown up with computer and e-gaming technologies and may respond positively to education gaming as stimulating and effective learning tools. This interactive workshop will allow participants to individually use and evaluate two geoscience e-games that have been specifically developed for geoscience students and funded by the HEA. The egames are available to use on various commercial hardware, including on internet-connected computers, iPhone, iPad and Android mobile devices. Subsequent workshop group discussions, coupled with pilot study results of Keele University science undergraduates, will evidence this technology for student engagement, usability and usefulness as well as their potential for virtual employability skills.

Keywords
geoscience, egaming, virtual, employability, serious games

1. Introduction
Increasingly digital technologies are being effectively utilised as science teaching and learning tools, in order to assist students to understand complex problems, for example, to visually show how sediments are preserved over time (see Mountney, 2009). Egaming has been suggested as one method for student engagement in often difficult to grasp scientific problems (Squire, 2008) but there are relatively few educational egames available; published articles focus on medical procedures for obvious reasons (e.g. Citak et al. 2008), forensic investigations (Ma et al. 2010) and engineering applications (De Sousa et al. in press).

Higher education geoscience teaching practitioners at Keele University have been involved for some time to fully engage undergraduates with multi-disciplinary scientific skills that they need, both to perform well in their studies and to gain and use in subsequent degree-related employment. This has involved a mixed methods desk- and field-based study approach (Cassidy & Pringle, 2010; Pringle et al. 2010),

but has now been extended into virtual reality (egaming), due to a combination of need for student inclusivity, students gaining a consistent experience available on-demand and increasing field equipment and fieldwork costs.

2. Virtual Geoscience Trainers

Funding awards by the HEA has allowed dedicated advanced computer programmers and 3D digital artists & designers to develop two geoscience trainers using different approaches.

The first trainer is a closed-question version with set questions and multiple answers. Used on an internet-linked computer, the trainer is designed so users are a HE graduate level-entry employee of an environmental company; a virtual client (avatar) requests assistance to locate a mineshaft (Figure 1). Once the scenario is completed, users review actual collected data (as based on a published case study – Pringle et al. 2008) and choose where the mine-shaft is; if successful the user is congratulated; a 'score' and humorous job title, transcript and case study link are provided. The script is also designed for users, by choosing different questions/answers, to progress through the exercise differently; this encourages users to repeat the trainer and have subject knowledge expanded, reinforced and thus improving the overall learning experience.

Figure 1. **Screen grab from VGT1 showing answer to user query on mineshaft information, information pop-up box and potential user answers.**

The second trainer is an egame, comprising a 3D virtual environment based on a real sites' geoscientific data. User(s) can explore the virtual environment via internet browser, as a standalone application on a PC or Apple Mac and is potentially available on mobile devices which support the Android or Apple iOS platforms (such as iPad). Designed to lead users, acting as forensic science CSIs, through stages investigating a crime scene; once the desk-study and initial reconnaissance stages have been completed (Figure 2) users then have complete freedom to roam the 'crime scene', decide upon and operate search equipment (Figure 3), plant flags at

likely burial positions and decide anomalous areas for subsequent intrusive investigations (Figure 4). The VGT2 programme randomly moves the burial location and associated data when loaded, so repeat users are still challenged; a linked game time leader board also encourages refinement of search skills. Once completed, a success/failure newspaper article appears, game transcript and link to the published case study (Pringle & Jervis, 2010).

Figure 2. **Desk Study & Reconnaissance**

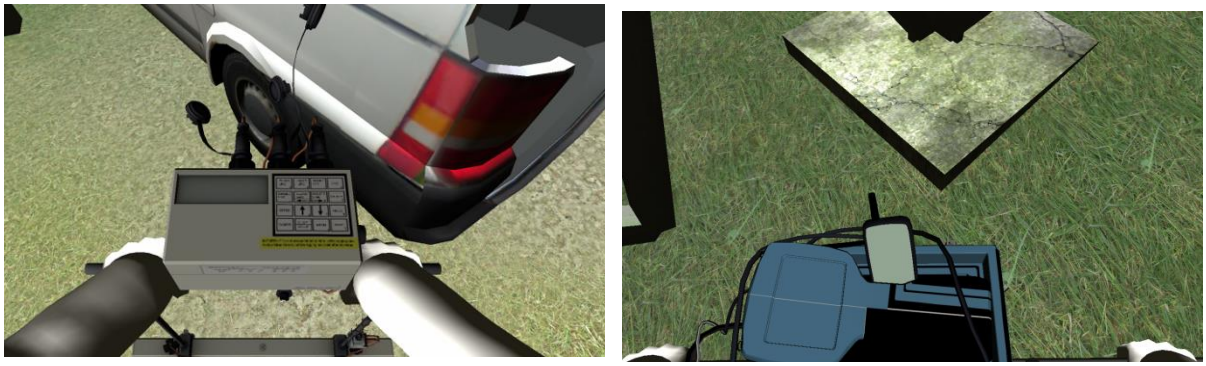

Figure 3. **Screenshot from VGT2 showing virtual equipment used on location in the 'crime scene'.**

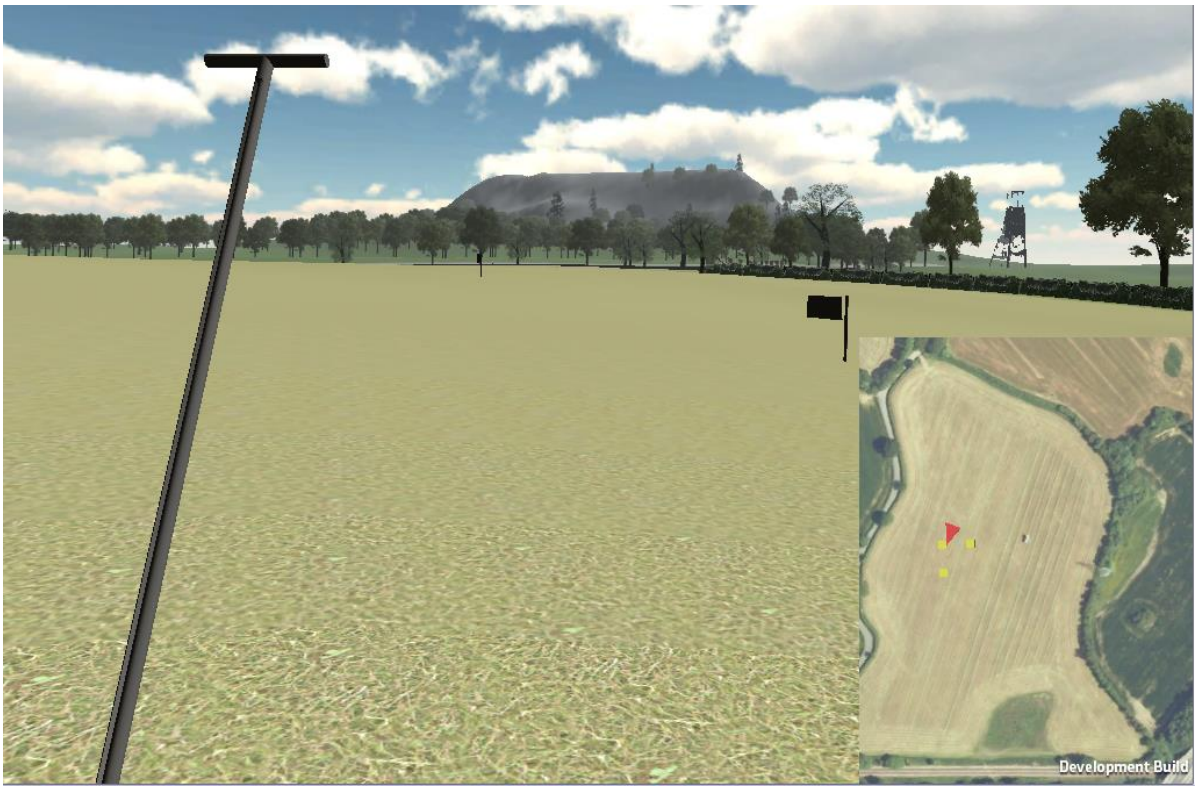

Figure 4. **Screenshot from VGT2 showing the virtual environment (coal-mine in background), soil probe option being used, user-dropped flags indicating anomalous positions and location map (inset).**

3. Pilot Keele HE student studies

A current study (n=100) involving HE Keele University Geoscience 2nd years and Forensic Science 3rd year 2011-12 undergraduates found 100% had played computer games with 65% currently playing daily or weekly (compared to ~30% of the staff/postgraduate control group, n=30). Unexpectedly less than 25% of students had used egaming previously for educational purposes. Student-preferred learning environments were: (1) laboratory practicals, (2) fieldwork, (3) small group work and, (4) lectures, suggesting 'learning through doing' is still as popular as evidenced by other authors for effective learning.

A small study involving Keele University HE Geoscience 3rd year 2010-11 undergraduate students (n=11) highly rated the VGT1 after use, anonymous comments including: *"a great fun interactive learning tool"*. They also highly rated its quality which was gratifying and the ability to comprehend content (Figure 5). An un-expected outcome was they subsequently read the case study article on which the game was based. One student commented: *"useful to see how an actual job would work"* and *"could I put it down on my CV?"* as it showed 'work experience' and virtual employability skills! These results are reported in Pringle (in review).

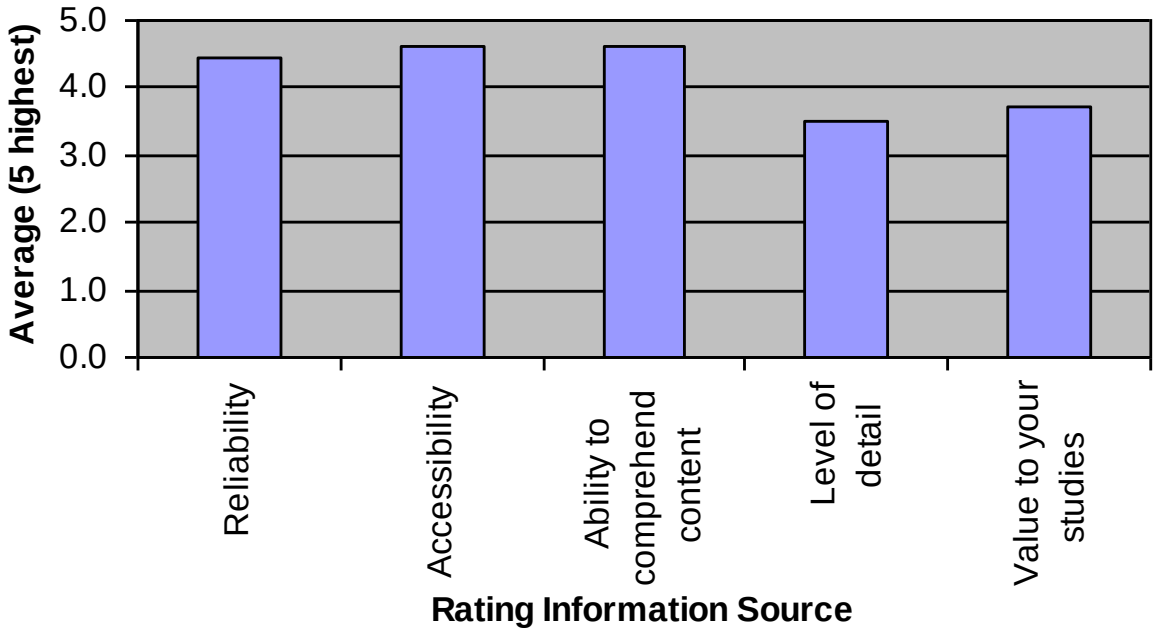

Figure 5. *Graphical summary of answers to 2010-11 HE students rating VGT1 quality (average of 4.2).*

At the time of writing, VGT2 has yet to be trialled on students but hopefully will provide positive feedback based on the VGT1 study results.

4. Conclusions

The educational science egames developed in this study were perceived by current HE undergraduates at Keele University to provide informative and effective complementary learning tools to more traditional learning environments. As well as providing a different learning experience to most science courses, they also provide a consistent experience for individual students and for different cohorts – currently difficult to replicate in laboratories or in the field, whilst providing enough variation to keep users interested and engaged.

Obviously this project took advantage of funding opportunities and in-house specialist and experienced computer programmers – especially for the VGT2 immersive egame that would be rarely found elsewhere in HE; however these

egames are available for other teaching practitioners to use; for the VGT1 online by registering with the author, or simply downloading the VGT2 from the authors, and later from online market places such as the Apple App Store. It is envisaged that further funding will allow programmers to provide a 'template' for a VGT1 closed-type game that teaching practitioners could utilize to create their own, bespoke egames.

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