

A virtual surveying fieldcourse for traversing

Henny MILLS and David BARBER, UK

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Summary

This paper presents the development of a virtual surveying fieldcourse based in the first instance on a virtual interactive traverse learning tool. Residential fieldcourses have been carried out in Geomatics degree courses successfully for many years and have found a wide appreciation for learning amongst students. However, the escalating cost (both financial and staff time) of running residential fieldcourses have led to cancellations and cut-backs in the subjects of Geomatics at Newcastle University, UK. Recently, virtual fieldcourses have increasingly been recognised as tools to enhance the student learning experience in higher education. It was aimed to develop a virtual surveying fieldtrip consisting of both a virtual fieldtrip and a virtual laboratory. A virtual fieldtrip can be created through the use of supporting mapping and photography of a specific area. In this study, however, it was aimed to develop a more interactive virtual traverse tool to form a virtual laboratory.

The observation and calculation of a traverse is one of the most complicated, but at the same time one of the most important, basic surveying skills which needs to be obtained not only by Geomatics students but also by students of related subjects, such as civil engineering and physical geography. A virtual interactive traverse learning tool was developed to enable students to successfully understand the complexity of a traverse. It was constructed for the simulated observation and calculation of a surveying traverse. The tool was set up to consist of an unlimited number of traverse examples and can easily be extended by further traverse examples, e.g. of different spatial locations, at any time. A template for the virtual interactive traverse learning tool was developed in AJAX. This allowed to develop the tool as an internet site, allowing access to be time and spatially independent. The presentation of the traverse is supported by maps and QuickTime panoramic photos. The traverse observations are carried via hotspots on maps and photographs, which allow zooming to the target and the measurements, consisting of slope distance, vertical and horizontal angle, to take place. Following the virtual data collection, the traverse can be calculated by the student and compared on-line against the actual answer via an on-line traverse form, allowing an immediate assessment of the observation and calculation.

The virtual interactive traverse learning tool serves as an excellent first-year experience and allows students to better understand the basic surveying method of traversing, on which they can build in their following years at the university. The aim of the tool is to improve the understanding and learning of surveying methods, traversing in particular, for first year students. It additionally allows students, to self-assess their traversing observation and calculation skills.

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1. INTRODUCTION TO THE VIRTUAL INTERACTIVE TRAVERSE LEARNING TOOL

This paper presents the development of a virtual surveying fieldcourse based in the first instance on a virtual interactive traverse learning tool (VITLT). The VITLT was developed at Newcastle University's School of Civil Engineering and Geosciences to support the teaching and learning experience for the traverse observation and calculation for a variety of student groups. Recently, virtual fieldcourses have increasingly been recognised as tools to enhance the student learning experience in higher education (GEES_Worcester, 2007). The UK Higher Education academy defines a virtual field trip as a “type of simulated field trip undertaken through the Internet” and a virtual laboratory as a “technological instrument that allows the simulation of laboratory or other equipment on a computer” (HEAcademy, 2007). Both components are overlapping in their definition and have to be present in a virtual fieldcourse (VFC). Virtual in terms of a virtual fieldcourse has also been described as a ‘digital alternative representations of reality’ (Phipps, 2001). This paper presents the results of the development of the VITLT as a virtual laboratory with the support of a virtual trip, based on support maps and photography of a specific area.

1.1 Surveying at Newcastle University

Surveying, is currently taught as a Stage 1 and Stage 2 modules in the Geomatics (c. 45 students), Physical Geography (20 students) and Civil Engineering (c. 85 students) undergraduate degree programmes at Newcastle University, consisting of numerous practical sessions, in addition to lectures. Residential fieldcourses, traditionally run over eight to 14 days, are seen as an effective learning experience for students to gain competent knowledge in surveying. However, the escalating cost (both financial and staff time) of running residential fieldcourses have led to cancellations and cut-backs in the subjects of Geomatics at Newcastle University, UK. Geomatics students still experience an eight-day surveying fieldcourse in the first year of their undergraduate degree, however the surveying fieldcourse for civil engineering students has been shortened into six practical sessions spread through the student’s first academic year. These differences in surveying experience have resulted in a large division in knowledge and skill in surveying between the two students groups, being highlighted in the annual exam marks in the common first year surveying module. Efforts are therefore necessary to improve the civil engineering learning experience and introducing alternative assessment methods. A VITLT was built to improve the learning experience of primarily civil engineering students (but also Geomatics and Physical Geography students) by developing an e-learning tool.

2. E-LEARNING AND THE USE OF VIRTUAL FIELDCOURSES

Fieldwork and fieldcourses are an important learning tool for any Geoscience degree. Residential fieldcourses have been carried out in many studies successfully for many years and have found a wide appreciation for learning amongst students. Virtual fieldcourse aim to enhance the learning experience of students in the context of existing residential fieldcourses. Any virtual fieldcourse

development can be understood as an inspiration to improve the overall student learning experience (Phipps, 2001). In such context, it is considered that a VFC should be based on a fieldwork components if possible, the pedagogy, technology and data (Moore, 2006b).

VFCs have now been developed at several institutions across the world and in the UK. Existing UK VFCs range from live web-cameras to full interactive virtual fieldtrips (GDN, 2001). An example for an existing VFC is the development of a Dark Peak virtual tour as a introduction and preparation tool for a geography fieldcourse (McMorrow, 2005). It took up to three years to develop the complete virtual tour, highlighting the cost and time associated with its construction. A student survey for this virtual tour highlighted that students got mixed enjoyment out of using such learning tool and did not necessarily see it as an improved learning tool to help their understanding of the subject (McMorrow, 2005).

The evaluation of further existing VFCs has shown their potential as a new and innovative learning experience for students and has been accepted by students for that reason (Spicer and Stratford, 2001). On the other side, the students strongly expressed their opinion that a VFC should not replace any existing real fieldtrips (Spicer and Stratford, 2001). It shows that VFCs are no a substitute of any residential fieldcourses and should not be considered as such. Even if the material could be taught with a VFC, students would miss out on a student life experience. Residential fieldcourse can help to develop transferable skills, such as group and project work, time management and if anything are of high potential for the social life experience of a student.

VFCs have been accepted by students as a modern and innovate learning method and students particularly enjoyed the use of such for this reason (Spicer and Stratford, 2001). The preparation of real fieldwork and – courses can be aided by a VFC, as it helps to provide students with new information in advance to the fieldwork (Warburton et al., 1997). It can therefore fulfil the following teaching and learning objectives: planning fieldwork, preparing for fieldwork, providing regional context, briefing on health and safety issues and improving learning acquisitions (Warburton et al., 1997).

VFCs can help to access areas and environments which are otherwise limited due to costs, distance or access requirements (GDN, 2001). On the other hand, the costs of VFCs are often underestimated, as any new development in the virtual world involves costly starting costs (Issroff and Eisenstadt, 1997). Additionally to the cost and time consuming production, VFCs require specialist computing and web-management skills which may have to be obtained, requiring additionally training for staff members (Curry and Burton, 2006). This let to the conclusion, that the development of a VFC does not automatically promise a new successful teaching resources or a revolution of teaching.

3. DEVELOPMENT OF THE VITLT

3.1 Implementation of the virtual traverse toolkit within the existing teaching

The aim of the VITLT is to improve the understanding and learning of surveying methods,

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traversing in particular, primarily for first year civil engineering students at Newcastle University. It will additionally allow students, to self-assess their traversing observation and calculation skills, instead of the currently used summative assessment. The VSFC module will also be made available to Geomatics and physical geography students before and after the Stage 1 residential fieldcourse, as it will consolidate their surveying knowledge.

The development of the VITLT has been handicapped by the amount of resources available to develop it. Despite the Newcastle University funding for 1 ½ months, the total time and costs required for the project were difficult to predict initially. A further barrier can be presented by the student group. It is not guaranteed that students will accept the VSFC as a new learning tool and will automatically gain more understanding for the subject from it. It is therefore important to integrate students as much as possible into the development of the VSFC.

The following recommendations, gained of previous studies, should consequently be considered when developing the VITLT (McMorrow, 2005):

- 1 Use of linear structure including a link on each page back to the main map
- 2 Use of annotated graphics
- 3 Offer self-assessment at the end of the on-line exercise.

3.2 Content of the VITLT

The observation and calculation of a traverse is one of the most complicated, but at the same time one of the most important, basic surveying skills which needs to be obtained by students. Geomatics students seem to successfully understand the complexity of a traverse at the end of the residential fieldcourse, during which they have to fully observe and complete two large traverse networks. Civil engineering students on the other hand do not observe a complete traverse during their degree course, as the limited timeframe of three-hour practical sessions is not sufficient to complete a traverse. This deficiency could be overcome with a virtual, interactive and simulated traverse observation and calculation learning tool.

In the initial part of the development of a Newcastle University VFC, a virtual interactive traverse learning tool was developed. It was constructed for the simulated observation and calculation of a surveying traverse.

3.3 Data for the VITLT

The VITLT is initially based on several traverses around Newcastle University campus. Maps and photographs are presented together with an explanation and description in a surveying context to familiarise students with the setting of a realistic traverse observation environment. The use of digital video recording can be of an advantage over digital photography for a virtual fieldcourse, as it allows better panning of the scenes, the option of adding sounds and a possible dynamic realism (Moore, 2006a). Data storage however may be an issue of lots of video are used, as 14 minutes of video tape can provide up to 10GB of data unless unzipped with the potential loss of data quality (Moore, 2006a). Due to those reason, the use of video was not used in the initial set-up of the VITLT.

The VITLT developed is not just depended on the data collection but also its analysis and presentation, requiring good preparation before any data is collected. The suggested use of pop-up answers in the style of “Did you know...” were abandoned in a test trial at Manchester University, as students would just click them away rather than actively trying to obtain the knowledge (McMorrow, 2005).

3.4 Development of the VITLT

Virtual observations at each traverse station were realised via hotspots on an overview map and 360 degree panoramic images. This allowed the students to gain a similar spatial orientation to that which they would have when observing a real traverse. The student can pan and zoom the image to locate the target and click to take a measurement, the horizontal, vertical angle and slope distance are displayed in a virtual total station display. Following the virtual data collection the traverse, as calculated by the student based on the given observations, can be checked on-line against the stored answer, allowing immediate feedback to the student. The virtual interactive traverse tool was prepared using Asynchronous JavaScript Technology (AJAX), allowing a dynamic website to be created, as required for the proposed tool.

4. THE NEWCASTLE UNIVERSITY VIRTUAL INTERACTIVE TRAVERSE LEARNING TOOL

This section describes the structure and content of the VITLT in more detail. The VITLT was developed as a webpage and is served over the internet. The webpages are hosted on the Newcastle University Internet server and are linked to an additional SQL database server where the traverse data is stored.

The VITLT design consists of the two main elements: admin pages allowing new traverse to be entered and the student exercise pages.

4.1 Admin setup of the VITLT

The admin webpage of the VITLT summarises the existing traverses within the system to the tool administrator (Figure 1). Additionally, the webpage allows to set-up new traverses together with data, pictures and design.

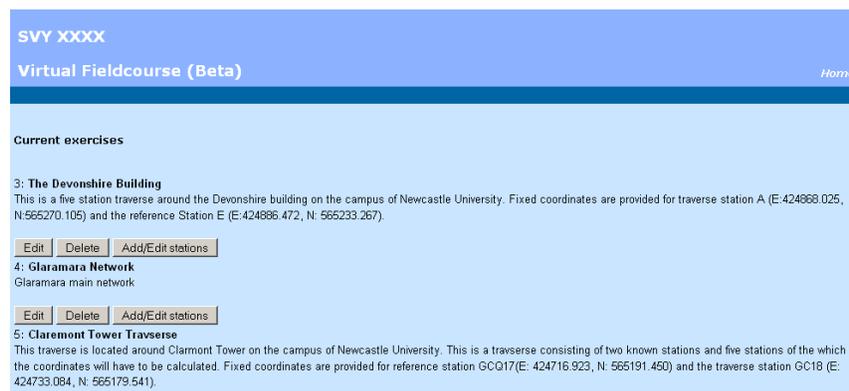


Figure 1: Admin page of the VITLT

New traverses can be added at any time to the VITLT. Any new traverses are required to have been calculated and the complete solution entered into the project database. Coordinates of the reference stations are required, as well as the calculated misclosures. Additionally, each station has to have entered a horizontal angle, vertical angle and slope distance reading for foresight and backsight observations. Also required are reduced horizontal and vertical angles and the actual final coordinates of all stations. The student's answers are compared against these stored answers (Figure 2).

Figure 2: Set-up of a new station on the VITLT

4.2 The student VITLT webpage

The first student page of the VITLT informs the students of the outline, objectives and assessment of the VITLT (Figure 3). Once the students familiarised themselves with the objects and aims the exercise, a traverse can then be selected.

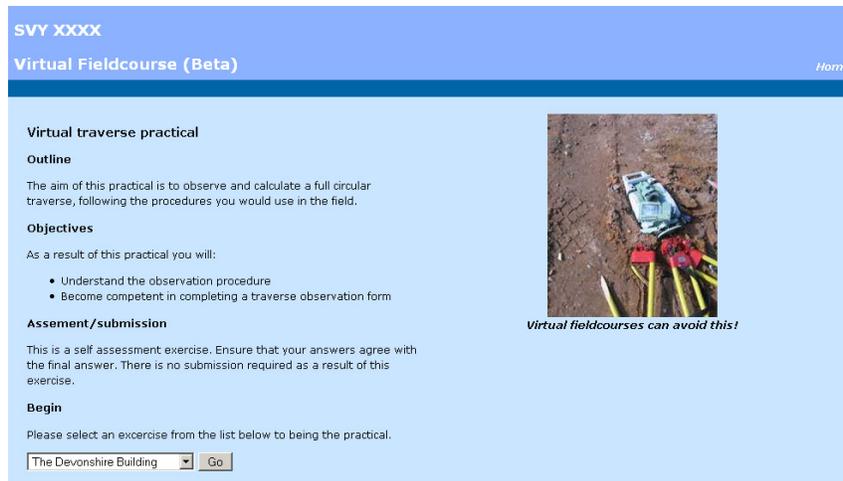


Figure 3: The students look at the VITLT

Once the traverse is chosen, the students are presented with a Google Map overview of the traverse stations. The student must decide which station should be observed first and has to choose the station. This loads the QuickTime movie presenting a 360° picture panorama. It allows the students to scroll and zoom around in the picture (Figure 4). Once the other station is identified, a measurement can be carried out by clicking on the image. This measurement exists of a traverse observation consisting of the horizontal and vertical angle together with the slope distance (Figure 4).

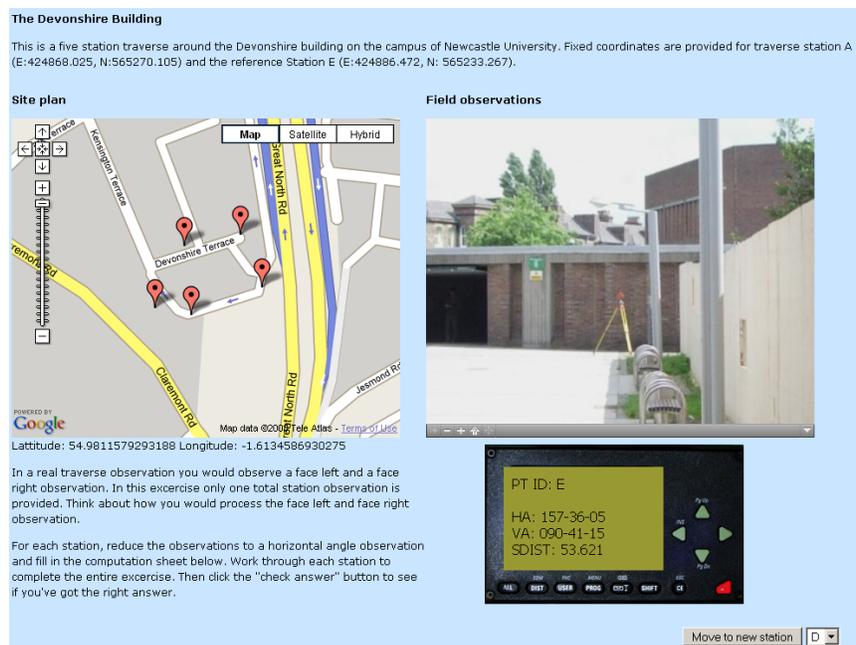


Figure 4: Set-up for traverse observation from one station

Once all measurements are observed, the students are required to calculate the traverse data by hand and fill in the traverse calculation sheet (Figure 5). The traverse calculation sheet is based on the Newcastle University template for the calculation of a 2D traverse.

STATION	A to B	B to C	C to D	D to E	E to A
BACKBEARING					
HORIZ. ANGLE					
FWD. BEARING					
HORIZ. DISTANCE					
dE					
FWD. EASTING					
dN					
FWD. NORTHING					
REF CLOSING BG		REF CLOSING E		REF CLOSING N	POSITIONAL MISC
CALC CLOSING BG		CALC CLOSING E		CALC CLOSING N	BEARING OF PM
BEARING MISC		EASTING MISC		NORTHING MISC	PROPORTIONAL ERROR

Figure 5: Template for the calculation of the traverse

All data inserted by the students is assessed in real time and an indication for a correct or incorrect value is given. The traverse observation and calculation is so far only limited to a 2D traverse. Further work may extend the exercise to a 3D traverse, requiring the students to calculate the heights of each station.

5. THE VITLT AS A STUDENT LEARNING TOOL

The VITLT was tested by several Stage 3 Geomatics students. The students used their experience of studying surveying and having carried out several traverse observations and calculation. It enabled a comparison to their knowledge and assessment of the use of the traverse fieldcourse from an experienced point of view.

The student questionnaire showed their appreciation for the VITLT, as an e-learning tool and their enjoyment of using such tool. The current design and navigation tools were praised by the students. All students agreed that the VITLT would a useful tool in a surveying context for their study. The potential of VITLT to help the learning and understanding of a traverse was highlighted. Additionally, it was noted that students seemed to prefer the on-line traverse observation and calculation to the traditional hand-calculation using a paper traverse calculation form. Nevertheless, the students did not see the e-learning tool as a replacement for a traverse observation as carried out on the fieldcourse, but suggested that it could be used as a preparation and revision tool. The main negative respond received from the students was based on the current instructions and set-up of the VITLT. More instructions on how the VITLT has to be executed were suggested, as a lot of prior knowledge is currently assumed on how a traverse observation and calculation is carried out. The student questionnaire also highlighted some technical

problems, such as the requirement of QuickTime to be installed on the computer and the missing option of saving data and completing the exercise at a later time.

The feedback of the students on the interactive learning tool will be used to iteratively improve the tool, ensuring a student friendly development, user environment and accessibility, leading to its acceptance by students. If proven successful, the VITLT will subsequently be further developed to a complete and comprehensive suite of modules, consisting of different surveying methodologies set in a simulated fieldcourse background.

6. CONCLUSION AND FUTURE DEVELOPMENTS OF THE VITLT

The virtual interactive traverse learning tool was developed as the first of a series of modules for a comprehensive Virtual Surveying Fieldcourse. Further extensive assessment will have to be carried out regarding its influence on the student performance. Additionally, further funding resources have to be found and secured to allow a further development to a complete and comprehensive suite of modules, consisting of different surveying methodologies set in a complete simulated fieldcourse background.

The VITLT serves as an excellent first-year experience and allows students to better understand the basic surveying method of traversing, on which they can build in their following years at the university. The aim of the tool is to improve the understanding and learning of surveying methods, traversing in particular, for first year students. It additionally allows students, to self-assess their traversing observation and calculation skills.

6.1. Future development of the VITLT

Several developments are planned to extent the VITLT. However, all potential developments are subject to securing additional funding. Firstly, it is aimed to extent the traverse calculation from a 2D traverse to a full 3D traverse, including the height calculation of each station.

Naturally, the VITLT will be continuously extended with further traverse, such as the traverses being based on the Geomatics residential fieldcourse in Borrowdale, Lake District, UK. Further possible improvements for the VITLT relate the design of the tool and the presentation of the data. The presentation of each the traverse stations on three-dimensional terrain model, overlain with near-vertical aerial photographs, would help the visualisation of the traverse for the students. Additionally, it is aimed to ask students to set-up a total station interactively at each traverse station, for which the simulated equipment will be provided within the learning tool.

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BIOGRAPHICAL NOTES

Henny Mills studies at Geodesy at University of Technology of Dresden, which she completed with a Master of Geodesy. Following this, she undertook a PhD at Newcastle University, in the area of image processing and the mapping from high spatial resolution imagery using advanced classification algorithms. Recently she has investigated the monitoring of landslides, using a low-cost GPS based approach with the EU-LESSLOSS project, as a Research Associate at Newcastle University. As her current role as Geomatics Teaching Associate, she is involved in aspects of teaching in all Geomatics degrees at Newcastle University.

CONTACTS

Dr. Henny Mills
School of Civil Engineering and Geosciences
Newcastle University
Newcastle Upon Tyne
UK
Tel: +44 191 2225042
Fax: +44 191 2226502
Email: Henny.Mills@ncl.ac.uk
Web site: www.ceg.ncl.ac.uk