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Assessing the Effect of Constructivist YouTube Video Instruction in the Spatial Information Sciences on Student Engagement and Learning Outcomes

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Abstract

This paper examines the potential of pedagogically designed video demonstrations in supporting the learning requirements of students in the Spatial Information Sciences (SIS). Currently, over three hundred full and part-time students in the College of Engineering and Built Environment undertake a module in Land Surveying each semester and although these students range in discipline and academic level, they all share a need for basic information and instruction in the area of practical land-surveying techniques. To accommodate this highly practical subject area, 50% of contact time is normally dedicated to group-based field exercises. To enhance the students' practical learning experience in Land Surveying modules and provide a mobile (m)learning resource a number of short videos with voice-over instruction have been developed. These short YouTube clips show the correct use of survey equipment and can be directly accessed in the field via a web and video enabled mobile platform. This study highlights the effectiveness of designing high quality mlearning resource material for use by undergraduate students. Outcomes of the study indicate that the use of videos hosted on YouTube is very positive as it presents few barriers to learners in terms of access and usability. Learners were shown to have the tools and desire to engage with mlearning materials. Furthermore, the use of multi-media resources was shown to be effective in improving learners' confidence in their practical abilities and increased their retention of key topics when formally assessed. From this study it can be concluded that video and related quality multimedia mlearning materials will play a significant role in serving the needs of 21st Century learners.

Keywords: Active learning, Geomatics, mLearning, Video, Surveying

Introduction

Constructivist learning theory maintains that when skills are acquired in a meaningful context they have added value to the learner and thus learners with existing skills and previous experience in diverse areas should be predisposed to learning and can take advantage of previous real-world knowledge (Jonassen, Peck & Wilson, 1999). Therefore when educating adult learners the constructivist approach to learning is very effective and appropriate as learners can construct meaning and derive the relevance of information from firsthand experiences (Jonassen, Peck & Wilson, 1999).

Context-based learning tools including instructional technology such as video offer many advantages in the development of learners' knowledge. They can convey information in an interesting way and develop complicated contexts in a simplified manner (Cognition and Technology Group, 1992). Critically when using video, learners have the advantage of both auditory and visual symbol systems which together have been found by Baggett (1984) and Kozma (1991) to provide visual systems which enable learners to construct detailed mental representations of the material provided thus providing additional and complementary information supporting learning. The advantage and superiority of video when learning complex skills and in exposing learners to situations where problems, equipment and events which could not have been otherwise demonstrated has been suggested by Anderson, Armbruster & Roe (1989). Video as a teaching, learning and training tool has been successfully adopted by many educators in recent decades (Zubert-Skerrit, 1984; Ellington, Percival & Race, 1993; Maier & Warren 2000; and Macurik *et al.,* 2008). However, the success of video as an instructional tool is very dependent on the design of demonstration material and also how it is employed. To be beneficial, Cennamo (1993) contends that active learning must take place during the video presentation, thus learners should be mentally engaged in the learning process and motivated to learn. In recent years, developments in ICT have provided new opportunities for streaming digital data for learning and teaching support and there has been exponential growth of online video production and viewing much of which can be attributed to YouTube (Snelson, 2011, Tan & Pearce, 2011). Indeed the usage statistics published by YouTube since its creation prove its role as a driving force in the upsurge of online video activity (YouTube, 2014). Course designers can easily tap into the vast cyber-library of free video material currently available on the web through its online public distribution system (Snelson, 2011). Or where suitable material is not already available the production of video has become easier and it is relatively simple to create short customized video clips suitable for specific course topics. In using video to demonstrate context based materials a micro-level instructional design process which focuses on small units of instruction to create an educational product as defined by Snelson & Elison-Bowers (2009) is the most appropriate approach. In the case of survey education many ICT developments have been referred to in detail by FIG (2010), the most recent being the advent of mobile devices such as internet enabled smart phones. The availability of constructivist context-based video clips freely accessible online via YouTube can now deliver the real potential for mlearning on site at the appropriate time.

Although technology offers many innovative features that can make instruction more appealing to learners in a mobile environment, successful learning is very dependent on student motivation. Much research has been undertaken in the area of analyzing learner motivation and designing motivational tactics for educators and the ARCS (Attention, Relevance, Confidence and Satisfaction) model of motivation developed by Keller (1983) is one of the most widely applied. This model classifies the major motivational concepts and theories into four categories or conditions: i. Gaining learner attention, ii. Establishing relevance of the instruction, iii. Building confidence with regard to real expectations and iv. Satisfaction by managing learners' intrinsic and extrinsic outcomes. If each of these conditions is met then students are likely to have a high level of motivation. Thus for video instruction to be a successful learning tool it should promote learners' motivation whilst delivering micro-level instructional information.

Context

Land Surveying is an inherently important foundation subject across a diverse range of engineering and surveying disciplines. This is evidenced by the learning requirements of over 300 students in the Dublin Institute of Technology (DIT) currently undertaking a module in Land Surveying. These students range in discipline from pure Land Surveying (Geomatics) to students of Architecture, Construction and Engineering, in academic level from 4-year Honours Bachelors Degree to 3-year Diploma and in learner type i.e. from full-time student or professional learner to part-time students in full-time employment. They each however share a common need for foundation knowledge and instruction in Land Surveying instrumentation. Currently, these needs are met by 6 diverse lecturing and demonstration staff from different Schools and Departments within DIT with on average, 4 weekly semester hours over 2 semesters. These contact hours generally translate into 100 learning hours per semester which equates to a 5 credit module whereby the credits are defined by the European Credit Transfer System (ECTS), thus making them transferrable across the Institute and Europe. The student cohort size is strongly dependent on the learner type with full-time students accounting for, on average, class sizes of 35, whereas professional learner cohorts' are typically half this size. The DIT approved ratio in practical demonstrations for tutor to class groups is 1:16 which creates obvious difficulties in knowledge exchange and dilution of skills transfer for both learner types.

Methodology

This study aims to investigate the potential of fine-grained instructional video clips to engage adult learners across a number of courses in active learning. Objectives of the study include designing and producing small units (micro level) of video instruction and assessing the accessibility and usage of this material in addition to their impact on learning. Similar to a study carried out by Choi & Johnson (2005) the learning (comprehension and retention) and motivation (ARCS) of a sample of learners were examined by comparing learners' perceptions of video-based instruction and traditional class-based instruction. However, this study differs significantly from previous studies in that the sample size is large (n=93) and the population characteristics differ as a number of independent groups/courses constituted the population and these were also assessed independently. Of additional interest to this study was the fact that a number of different tutors were engaged with varying cohorts, thus the ability of video-based instruction in standardizing messages and thereby increasing the fidelity of implementing instruction as proposed by Dusenbury, Hansen & Giles (2003) was also assessed.

To achieve the aim and objectives of this study the following research questions were identified:

1. Evaluate the video design at the micro level using a 7-step approach.
2. Evaluate learners' potential for mlearning using a phone usage questionnaire (n = 93).
3. Measure learners' motivation using open questions ranked in a Likert type scale (n = 122)

4. Evaluate learners' perceptions of understanding and retention with regard to course content using a pre- (n = 93) and post-test (n = 122) closed question Likert type scale.
5. Assess the appeal and usability of video using a questionnaire (n = 76).

Evaluation

Evaluation of this study is divided into a number of sections which respectively address the research questions. Production of the video materials, as presented here, builds on previous research by Snelson & Elison-Bower (2009) and McGovern, Martin & Moore (2008). Quantitative analysis of learning and comprehension is based on the methodology proposed by Choi & Johnson (2005) whereas evaluation of learners' motivation is based on Keller's (1983) model of motivation. Learners' potential for mlearning and also their perceptions of understanding and retention are unique to this study. It should be noted here that all participants volunteered to partake in this study and their anonymity was respected in all questionnaires and submissions.

Evaluate Micro-Level Instructional Video Design Process

The approach taken during the design stage of the instructional video clips has been previously described by Martin (2011) and is summarized here. The 7-step approach adopted is illustrated in Table 1, it includes the 4 core processes of micro-level instructional design (Processes 4-7) as outlined by Snelson & Elison-Bowers (2009).

Table 1: Instructional Video Clip Design

	Process	Description
1	Module content analysis	Seventeen module descriptors from four Schools: Spatial Planning, Construction, Architecture, Civil and Building Services were evaluated.
2	Module author consultation	Six module authors were consulted with regard to student cohort

		characteristics and learning objectives and module outcomes.
3†	Core Skills identification	Instructional demonstrations were used to map the educational objectives within a primary learning domain (cognitive, affective, psychomotor).
4†	Chunk information	Instructional content was designed in small chunks to demonstrate specific tasks which stand alone but can be combined to show complex skills.
5	Apply relevant learning theory	Cognitive theory of multimedia learning (Clarke & Mayer, 2011) and constructivist theory (Jonassen, Peck & Wilson, 1999) were applied.
6‡	Manage the technology	Ten video clips of 3-5 minute duration were produced, film quality was very high to ensure clarity when viewing the content in-house on larger screens. The videos were uploaded to YouTube
7	Evaluate the product	Informal evaluation of the video clips from all tutors was undertaken and used to modify the video clips before going live to students.

† Collaborative processes

‡ Technical support in video production was provided by DIT's Telematics Facility

Previous research carried out by McGovern, Martin & Moore (2008) clearly outline the creative, technical and logistical issues that arise when designing video material for online learning. However, a number of additional issues and advantages of video instruction are worth mentioning here. The value of a lesson can be measured not only by the learning outcomes but also in the case of digital media by its re-usability and fidelity of implementing instruction. Video has a unique quality in that it can be used to standardise a learning process by ensuring that analogous information is provided irrespective of the instructor. This was a critical point in this study and greatly informed the collaborative processes 3 and 4 from Table 1. An important aspect of online video instruction for international learners is the dual approach of audio and visual symbols for learning. This allows the learners, where language may be an issue, to revise important concepts in privacy and at their own pace.

The high cost of producing quality online instructional information has been found to be justified when the material has a long shelf-life (Mooney & Martin, 2003). Thus the greatest economical return is derived from the building blocks of subject material which remain a fundemental part of the core knowledge required by all learners. However, for non-traditional learning resources to be effective it is critical that its ease of use ensures the learning platform does not become an obstacle to learning. The use of videos hosted on YouTube is thus very positive as it presents few barriers to learners in terms of access and usability.

In total ten short video clips were completed, a student demonstrator was used in each clip and a voice-over provided instructional information. All videos were filmed on location in the Kings Inns Park where DIT students carryout field exercises, thus ensuring familiarity with the surroundings. The film quality was very high to ensure clarity when viewing the content in-house on larger screens. Individual video clips were designed to demonstrate very specific tasks which, when combined, show more complex tasks. All videos can be accessed on YouTube via the Martin Bondzio channel and individual video links are provided in an Appendix to this paper. A sample of screen shots from the videos are provided in Figures 1 to 4 for illustration purposes.

Figure 1: Levelling with an automatic level

Figure 2: Observing an E-Type staff

Figure 3: Levelling a theodolite

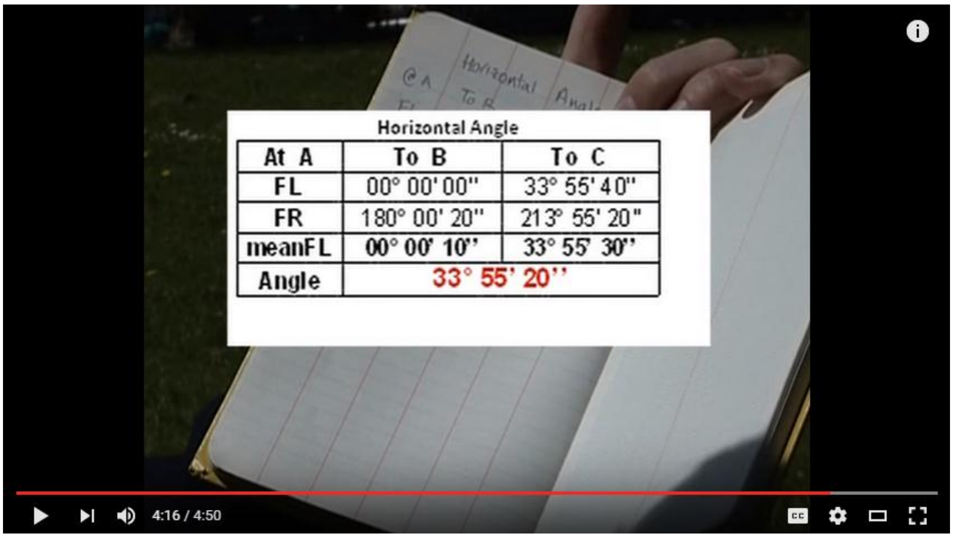

Figure 4: Measuring a horizontal angle

It should be noted that the video material designed for this study was not intended as a replacement for hands-on demonstration by the relevant tutor but as a mobile support resource embedded in the learning materials. In particular the material was designed to accommodate large student groups requiring instructional demonstrations. It was adopted by all course tutors involved in teaching foundation level Land Surveying in DIT in 2010/2011. Analysis of qualitative feedback from all course tutors indicate that the video material was useful in supporting class based teaching and learning as it provides additional standardized resource material on which tutors can depend. All course coordinators and tutors willingly engaged with the material and facilitated collaborative design thus providing a high quality resource with high re-usability value.

Evaluate Learners' Potential for mlearning

A phone usage questionnaire, administered to assess students' mobile learning potential, i.e. the technical capabilities of their current mobile devices and their willingness to engage with the digital materials, has been previously outlined by Martin (2011[b]) and is presented here in more detail. Participants in the study (n=93) included both full-time students (n=55) and professional learners (n=38) from the four Schools mentioned in Table 1.0 (Spatial Planning, Construction, Architecture and Civil and Building Services).

Of the 93, only 1 student was found not to own a mobile phone, 62% of students' phones were under 1-year old and 23% were less than 2-years old with the remainder (14%) greater than 3-years old. A slightly higher prevalence of older phones was found in the professional learner population but was not significant. As both student groups were found to own relatively new mobiles issues related to poor quality data streaming and slow internet access was not perceived to be problematic for the study.

Current student mobile internet habits were also analyzed and it was found that 72% (80% of full-time students and 61% of professional learners) had used their phones to access the internet with 41% (49% of full-time students and 29% of professional learners) having accessed YouTube to play videos from their mobile phones. The lower percentage of all students using the internet on their phones and streaming live video material via YouTube is explained by the significant cost of mobile charges which can be incurred using this medium. Therefore to prevent the learning platform becoming an obstacle to the learning process, students were provided permission to download the videos to their own mobile devices for viewing offline. The make and model of phone was also recorded but are of no interest in this study.

In addition to the high internet usage, the willingness of students to engage with the digital media was found to be very high, in total 66% of all students expressed an interest in the online material and 83 % believed that such mlearning instructional material would be beneficial in a practical environment. There was a significant difference found between the percentage of full-time students interested in accessing videos in this manner on the internet: 76% of full-time students as compared to 50% of professional learners. However both groups believed it would be useful to have access to instructional videos in the field (90% of full-time students and over 70% of professional learners).

The different patterns of mobile usage and engagement with online materials may to some extent be explained by the student cohort characteristics. Full-time students in DIT generally come directly to college from school with an average age of 18-21. This age group are very digitally aware and technically competent and thus very comfortable with the medium of online content. In contrast, professional learners in DIT range greatly in age (20-55) but on average can be said to be 5 to 10 years older than full-time students and thus perhaps not quite as comfortable with the internet and online video as a learning tool. The results presented here were also analyzed on a School by School basis to determine if any significant differences could be identified between different student cohorts i.e. Engineers, Surveyors and Architects, these were found to be insignificant.

Measure Learners' Motivation

An assessment of the impact of multi-media material on learners' motivation (i.e. attention relevance, satisfaction and confidence) for the different learner groups in a practical environment was evaluated using open questions ranked in a 4 point Likert type scale (Likert, 1932). Where 1 represented a strong agreement with the statement and 4 represented strong disagreement. All student cohorts had experienced traditional text-based instruction within their respective modules before the video based demonstration therefore a post-test only instrument was administered to evaluate perceptions of understanding, attention, relevance and satisfaction with the online instructional information. Quantitative data were analyzed with basic descriptive statistics.

The study found that 78% (mean 1.7 ± 0.8) of all learners preferred video materials to traditional class notes with 71% (mean 1.9 ± 0.8) finding that video provided more detailed information than traditional class materials and 66% (mean 1.9 ± 0.9) of students stated that they paid more attention to the video material than traditional class notes. No significant was found in the results between professional learners and full-time students.

Over 90% (mean 1.5 ± 0.6) of all students found the material to be directly relevant to their module, with no difference between the learner groups. This was an expected outcome as the collaborative design process ensured very high consistency of materials with all module descriptors and learning outcomes.

Learners' confidence in their abilities to emulate the skills demonstrated in the videos and incorporate them into real-world situations was very high and measured at 89% (mean 1.5 ±

0.7). Again no significant difference in results was found to exist between full-time students (88% mean 1.6 ± 0.6) and professional learners (94% mean 1.6 ± 0.6).

Qualitative feedback on student satisfaction with the video materials indicated that learners were very comfortable with video as an instructional tool and found the medium easy to use and very beneficial when used together traditional forms of teaching. It was found to be a good revision tool and more useful than traditional notes in real-world situations. A sample of student feedback is provided here:

'Being able to view the videos more than once helped reinforce my learning.'
'I found the number of videos and the amount of detail in the demonstrations effective for learning the skills required to measure a horizontal angle.'
'I would like more video demonstrations to be used in class.'
'I found it advantageous to view the videos on a pc in advance of a field class.'

There were no negative comments on the use of video as a support tool for teaching and learning and students have subsequently requested additional mlearning resources in video format. In particular, students have requested that similar resources showing basic survey computations be developed. This was an unexpected result however it indicates the high level of engagement with video as a learning resource.

Evaluates Learners' Perceptions of Understanding and Retention of Course Content

Assessment of the advantage of embedding video in the course material in terms of understanding and retention with regard to course contents was analyzed using a pre- and post-test instrument. All student cohorts had experienced traditional text-based instruction before the video-based demonstration within their respective modules. Factual recognition was evaluated using 11 closed questions ranked in a 4 point Likert type scale. Results from the questionnaire showed an average increase in understanding of 23.6% (pre-test 33.5% mean 1.9 ± 0.8 and post-test 57.1% mean 1.6 ± 0.7) in the basic survey methodologies presented across all student cohorts irrespective of NQAI level or discipline. Whereby full-time students showed a 37% increase in understanding (pre-test 36% mean 1.9 ± 0.8 and post-test 73% mean 1.4 ± 0.6) and part-time students a 26% increase in understanding (pre-test 26% 1.9 mean ± 0.8 and post-test 57% 1.5 mean ± 0.6).

Evaluation of the learning skills specifically enhanced by the video materials was evidenced through formal assessment of students during their practical field sessions whereby the authenticity of assessment ensures a link between academic knowledge and 'real-world' knowledge required. A test cohort (Geomatics - DT112/1, n=18) undertook an open book practical assessment in module SSPL1012 whereby access to the video material was available on site from the tutor. Practical assessment of this nature is of particular benefit to the Geomatics cohort of students as their sixth semester is spent on placement with a survey company where knowledge of practical survey skills would be considered a prerequisite. Students were not graded on this assessment but had a requirement to meet the learning outcomes as specified in their module descriptor i.e. they had to be able to undertake a horizontal angular survey from start to completion and return a set of reduced calculations. All but one student passed this exercise on their first attempt without requirement to access the video material.

Evaluation of Appeal and Usability of mlearning

On completion of the semester a final questionnaire was administered to learners. The purpose of this test was to assess the effectiveness of mlearning on mobile phones, the ease of use of the mlearning tool, the appeal of using such a tool and also the pattern of mlearning resource use during the semester.

Firstly, the effectiveness of YouTube videos in a mobile environment was evaluated using closed questions ranked in a 4 point Likert type scale for a population of 76 students (42 full-time students and 34 part-time learners). It was found that 82% (mean 2.0 ± 0.6) of students found the use of the videos either very effective or effective in correctly applying their knowledge to field work scenarios which on repeated viewing helped reinforce their learning. 84% (mean 2.1 ± 0.8) of learners felt that it was advantageous to view the videos in advance of field classes where the equipment would be used. No significant difference was found between the two learning groups.

Secondly, the ease of use of a mobile phone in terms of access of materials, visual acuity and audio volume was determined again using a 4 point Likert type scale. It was found that while approximately 50% of all learners had some issues with the mode of learning, e.g. the screen was too small or the volume too low, on average professional learners were 10% more likely than full-time students to have difficulties with the mobile platform.

Finally, the appeal of accessing learning material outside of the traditional classroom and in a video format was assessed and 84% of learners found that it was advantageous to view the videos in advance of field classes where the equipment would be used. The videos were accessed by 34% of learners as a revision tool from their home environment whilst 16% of learners used the videos to recap on the skills required while undertaking work on-site.

Discussion

This research has shown that video instruction, when well designed and chunked into manageable segments, provides a positive learning resource which augments traditional classroom and lab-based learning material. This validates previous research in the area by

Maucrik *et al.* (2008) and Buzzetto-More (2014). Furthermore, it has been shown here that in 2011 learners had the potential to connect and engage with mobile learning resources and are extremely comfortable in this online environment. A significant proportion of learners (78%) found the mlearning materials in this study preferable to traditional class notes. Learners today have even more advanced mobile devices and are increasingly expecting an mlearning environment. It has also been found that the use of the video materials increased learners confidence in their ability to emulate the specific skills presented. This is significant when developing future learning resources and confirms recent research in this area by Ljubojevic *et al.* (2014). The production of high quality online learning resources is however costly and time consuming and its re-usability to a wide audience is necessary to justify production. Although this study was limited to a specific discipline in the Spatial Information Sciences previous research into video instruction has proven effective in many other domains including science (Jarvinen, Jarvinen & Sheehan, 2012), sociology (Tan & Pearce, 2012) and medicine (Jang & Kyong-Jee, 2014).

Conclusions

Findings of the study indicate that learners are very receptive to mlearning and increasingly expect it as a resource. Students have the personal resources to access the materials in a mobile platform and are willing to engage with well designed mlearning material. In addition, such mlearning resources provide a very useful bank of standardized material on which tutors can depend to support their class-based teaching and practical demonstrations.

The 7-step instructional video clip design process as outlined in this study could be used as a template for other designers and researchers when considering developing mlearning resources. However, it should be noted that production of high quality video is slow process very much dependent on interdisciplinary support. Therefore a recommendation from this work is to establish an interdisciplinary mlearning team with the specific disciplinary knowledge and digital media acumen necessary to develop mlearning resources which have a broad spectrum audience.

Proposed future work is to increase the bank of mlearning resources within the discipline of Geomatics and Surveying incorporating the lessons learned from this project. The positive student engagement and their specific requests for additional resources will inform the materials developed into the future. Furthermore, further work should define the relationship between technology use and student outcomes - by comparing the final mark obtained to the number of students who accessed online materials using hypothesis testing.

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APPENDIX

Theodolite instruction videos on YouTube.

i. How to centre over a point: http://www.youtube.com/watch?v=EKE3ZwYaMms
ii. How to roughly level a theodolite over a point: http://www.youtube.com/watch?v=sA3ubs8vaug
iii. How to finely level a theodolite over a point http://www.youtube.com/watch?v=0hAOD4OGMGY
iv. How to carry out the Plate Level Adjustment on a theodolite http://www.youtube.com/watch?v=kvkXR-hKG04
v. How to measure a horizontal angle using a theodolite http://www.youtube.com/watch?v=7aYsAwXlZkg

Level instruction videos on YouTube.

i. How to set up a survey tripod http://www.youtube.com/user/MartinBondzio#p/u/9/O3Dp1kjI8gY
ii. How to set up an automatic level http://www.youtube.com/user/MartinBondzio#p/u/8/IIYAoNHPEao
iii. How to level the pond bubble in an automatic level http://www.youtube.com/user/MartinBondzio#p/u/5/v8-xGcBYAts
iv. How to remove parallax in a survey telescope http://www.youtube.com/user/MartinBondzio#p/u/7/AIBJILxQ3cE
v. How to read a levelling ‘E’ type staff http://www.youtube.com/user/MartinBondzio#p/u/6/o8d-5S1z0e8