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THE APPLICATION OF WEB 2.0 TECHNOLOGIES AS AN EXPERIMENTAL METHOD OF TEACHING REMOTE SENSING AT DIT, IRELAND

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ABSTRACT:

This paper describes the implementation of an experimental method of delivery for a module of remote sensing material to second year students on the BSc (Hons) in Geomatics at the Dublin Institute of Technology. The project began as a reaction to poor levels of student engagement and unsatisfactory grades, as well as the requirement to focus more on real-world type problems due to the implementation of a work-placement semester for third year students. Both pedagogical considerations (movement towards formative feedback, interactivity and group-based work) and the effect of technological drivers, such as the popularity of the internet in general and Web 2.0 tools in particular, led to the design of a two-part project where students engaged in group-work and individual research to explore remote sensing and close range photogrammetry concepts. The students found the new delivery and assessment to be generally successful with 78% recommending that the new format should be retained for future delivery. However, both the students and the lecturer involved envisage a number of changes, particularly in relation to group size and time management, for future deliveries.

1. INTRODUCTION

1.1 Geomatics Education at DIT, Ireland

Geomatics education in Ireland, offered only at the Department of Spatial Information Sciences (SIS) of the Dublin Institute of Technology (DIT), produces graduates at honours bachelor degree level after an 8 semester programme. In 2006 the SIS department carried out a full review of the existing geomatics programme to restructure it within a semesterised format, a newly-introduced DIT requirement. The programme committee also used this opportunity to revisit the programme content and better align it with current industry requirements and with technological and pedagogical advances (Prendergast *et al.*, 2007).

One major result of this reorganisation was the introduction of a practical semester in semester 5 to be undertaken by working either in industry or with public bodies, or by taking approved modules at a European University via the ERASMUS programme. This new development impacted on all modules taken prior to semester 5, requiring the content to be more intensive and industry-focussed in order to produce students who have mastered the technical and professional skills that are of value to employers.

Students entering work-placement programmes are required to participate as full members of a professional community. To this end it is essential that, in conjunction with their theoretical and practical knowledge in geomatics, they also display key or transferrable skills such as adaptability, written and oral presentation proficiency, the ability to work in teams, collaborative writing competence and research ability. While many of these competencies are included in the Professional Development module that is undertaken in semester 2 it is essential that these skills are revisited during semesters 3 and 4, and that they are applied to scenarios that approximate as closely as possible to work situations.

1.2 Remote Sensing Modules on the Geomatics programme

During Semester 1 students receive a very basic introduction to remote sensing as a component of the module Introduction to Geomatics which is delivered jointly to honours degree programmes in Geomatics, Spatial Planning and Environmental Management. The material is delivered via a total of nine hours of theoretical and practical sessions which introduce remote sensing sensors, imagery and their application to the geomatics, planning and environmental management professions.

Subsequently, in Semester 3 only the geomatics students take a module called Remote Sensing I which includes a more detailed review of satellite and airborne remote sensing principles and systems, close-range photogrammetry and basic digital image capture and processing. In the following semester, semester 4, students take the module Remote Sensing II covering topics such as the geometry of vertical aerial photography, stereo aerial photogrammetry including development of the collinearity equations, film and digital airborne sensors and lenses, project planning and ground control. These modules provide the foundation for Remote Sensing III and IV which are delivered in semesters 6 and 8. The later modules develop students analytical and synthesis skills in relation to a range of airborne and spaceborne sensors such as digital cameras & scanners, LiDAR and SAR.

In the previous format of the geomatics programme, mainly due to equipment and staffing constraints, each of the early Remote Sensing modules were delivered via 12 theoretical taught sessions (once per week for two hours) with a limited number of hands-on practical classes delivered to pairs of students typically once per 4 or 6 weeks.

Understandably, student feedback frequently reported problems of understanding and engagement with the subject matter due to this lack of hands-on experience and the theoretical nature of

the subject, particularly relative to other modules. This had the added effect of causing both student attendance and grades in the module to be less than satisfactory. This situation was unsustainable, particularly in light of the possibility of placing students in remote sensing companies or related public bodies for semester 5. Without changes to the module there was a danger that both the students and the employers would experience an unsatisfactory practical semester, with a potential secondary effect of damaging the programme's reputation and the student's future employability.

It was therefore considered essential to change these modules in order to improve the student experience, attendance and grades, and to produce students who would be valued during placement and longer-term employment.

1.3 Paper Structure

In the following sections a description is given of the steps taken to execute the necessary changes to the programme. Section **Error! Reference source not found.** describes the context within which the new module structure and delivery method were considered. This includes a discussion on relevant developments in pedagogical thinking with regards to teaching and assessment. Consideration is also given to a number of recent advances in information and communication technologies, in particular Web 2.0, and their impact on social interaction and education. Section 3 describes the implementation of the new method of delivery and assessment. Section 4 reviews the results of the experimental method from both a student and staff perspective. It considers failures in delivery and changes that can be made to improve future provision of remote sensing education to undergraduate geomatics students.

2. CONTEXT FOR CHANGE

2.1 Pedagogical Considerations

The change to a modularised and semesterised system of delivery at the Dublin Institute of Technology has brought about considerable adjustment in both assessment and teaching methods. For many modules, including remote sensing, the traditional form of assessment was an individual, written, unseen, time-constrained examination comprising approximately 70% of the total marks, with an individual or group-based project element contributing the remaining 30%. This type of assessment encourages cramming, often leads to a lack of higher level learning (Gow & Kember, 1993) and reduced information retention. Such assessment has also been shown to frequently fail to prepare students properly for work placement, in the short-term, and for a profession career, in the long-term. Similarly research has found that, particularly for technology-based education, delivery via standard lectures using a transmission model is less successful than delivery methods where students are actively involved in practical work. Group-based learning has also proven to be very valuable, particularly where graduates are preparing for careers where they are frequently employed as members of inter-disciplinary teams and are required to collaborate on equal terms with other professionals.

In acknowledgement of these considerations problem based learning (PBL) was implemented for the delivery of geodetic surveying and remote sensing modules in semester 7 of the geomatics programme (Martin *et al.*, 2006). While problem-based learning has been successfully applied to the early years of undergraduate education (see, for example, Bowe *et al.*, 2003 on the use of PBL for physics education at DIT) it was considered that application of PBL in it fullest form (including the use of reflective journals and monitored meetings) was unsuitable for the remote sensing module. This unsuitability was due to the need to ensure that students learned the core basic concepts of remote sensing without being confused or distracted by the need to also learn elements that are not necessary in preparation for work placement (for instance, having to concentrate on both reflective and technical writing). The level of resourcing required for PBL and the maturity of the students were also considerations that acted against its full implementation. However, the elements of PBL that refer to team work and the development of a range of transferrable skills will be developed in the selected implementation.

2.2 Technological & Social Considerations

The concept of Web 2.0 (a term brought to prominence by Tim O'Reilly in 2004) has changed the focus of web design and technologies from the provision of a passive service to the delivery of a product which enables user interactivity, particularly in the form of collaborative creation and information sharing. While this change in internet usage from passive to active has caused problems for educational institutes in relation to provision of internet bandwidth, misuse of IT facilities and reduced use of traditional research facilities, it has also had the advantage of producing more IT-literate students and students with an understanding of the power of online interaction between groups. Irish teenagers and young adults have embraced this phenomenon enthusiastically. In March 2008 in Ireland three social networking sites were listed within the top ten of most trafficked sites (3. Bebo, 7. Orkut and 9. Facebook). The rest of the top ten places were occupied by a number of search engines and by You Tube and Wikipedia, both of which also allow user interaction (Alexa, 2008).

Thus, in redesigning this module the author wished to take advantage of the willingness of students to engage with websites and thus utilise the knowledge gained by individuals through internet usage in a social capacity. As the Web 2.0 concept is also referred to as the "Read Write Web", this project intended to engage students in active internet research (reading) and collaborative website production (writing) using a range of Web 2.0 tools.

Since some of the main functions of social networking sites relate to the posting of information and commenting on a publically-visible website via a standard web browser, this is very similar in concept to the addition of information to a collaboratively written website, a Wiki. In this project the online free wiki provider pbwiki.com was used, mainly due to the high level of administrative control relative to many other providers, the existing community of educational users, and the absence of advertising (PBwiki, 2008). Two other Web 2.0 tools were also used in the project - the online social bookmarking site del.icio.us (Del.icio.us, 2008) and the social citation tool CiteULike.org (Citeulike, 2008) were used as repositories for collective information. After carrying out individual research on existing websites and using academic journals and databases students used the social sites to share the results with their group.

3. NEW DELIVERY IMPLEMENTATION

Although it was noted that problems existed in both modules Remote Sensing I & II it was deemed essential to gauge the success of a new delivery method on only the initial module (Remote Sensing I). As previously mentioned, one semester lasts 12 weeks (1 week was not available for teaching due to student induction) and 4 hours per week were allocated on the students' and one staff member's timetable. A decision was made to divide the module into two distinct parts to reflect the two major components of remote sensing systems & applications and digital imagery & close range photogrammetry.

3.1 Remote Sensing Systems & Applications (Part 1)

Part 1 of the module was designed to fulfil the dual functions of teaching introductory remote sensing subject matter plus making the students familiar with the Web 2.0 tools which would support their collaborative research, project execution and report writing. Because of the number of new elements being introduced this part of the module was awarded 30% of the overall module marks in order to allow time for the students to receive feedback and improve their skills with little penalty. Only two lectures were delivered using the standard lecture theatre method; these covered an introduction to remote sensing including the physics of the technology, the systems and their applications. Students also attended one structured tutorial which introduced a range of relevant websites for remote sensing publications (conferences, research groups/societies and journals), online tutorials, software and data providers, as well as the social bookmarking and citation sites.

Students were provided with 3 tasks, each of which related to developing an understanding of both airborne and spaceborne remote sensing systems and their applications. These tasks were to be researched and presented on a wiki site within a 3 week period. The elements to be included in the wiki were:

(i) Principles: write a reference section explaining the underlying physical principles of remote sensing (expanding upon the provided lecture material);
(ii) Spaceborne sensors: produce a categorised list of spaceborne remote sensing sensors for a given time period, find & share research articles on the use of five sensors for different applications, and produce a review of one such article.
(iii) Airborne sensors: produce a categorised list of currently available airborne remote sensing sensors, find & share research articles on the use of five sensors for different applications, and produce a review of one such article.

Once the formal sessions were complete the class of 38 students was divided into two groups and each group was provided with a private pbwiki site (Group 1:oners.pbwiki.com and Group 2: twors.pbwiki.com) to populate according to the tasks. Private wikis are only accessible for viewing and editing to individuals who have the necessary password. At the end of the project the sites were opened to public viewing. However, during part 1 passwords were used to limit access to students within particular groups. The general structure of the wiki was imposed by the defaults of the pbwiki format i.e. all pbwiki sites consist of a sidebar for navigation which is always visible beside the main content page. The students had the option of using the pbwiki editor tool in either full HTML tagging or What You See Is What You Get (WYSIWYG) modes. Since this student group had received no formal training in the use of HTML most chose to use the WYSIWYG editor.

The students were given complete freedom to decide how to divide the tasks amongst group members. Each group was allocated a separate room in which to discuss their plans for the site and its population. The two groups carried out their tasks in isolation from each other (protected by the passwords on the private wikis). After each group's initial student-only meeting to discuss site structure and task allocation, an action plan was presented to the lecturer. The lecturer only took the role of ensuring that no content had been forgotten and did not seek to enforce any structure on the projects, rather allowing the natural leaders within the group to come forward.

Students were informed that all individual contributions to the wiki could be tracked and that assessment of the module would be based on a 40-60 weighting between group and individual contributions, respectively. The pbwiki retains a history of edits to each page by named users and has a tool for comparison between revisions. Since there was a danger that students might only focus on 'their' content and therefore not actually achieve the learning outcomes of the module, individual marks were assigned for the wiki contribution (20 of 60) and for an individual interview (40 of 60) which required the student to review all of the material on the final wiki. It was hoped that these weightings would ensure that:

- the quality of the overall website would be high because all students within a group had a significant interest in the final product, and
- no students could be 'carried' by the rest of the group because their individual contributions were tracked and they were required to demonstrate understanding via individual interview.

An element of peer-review of the wikis was introduced in order that the two groups would evaluate, and potentially learn from, each others' achievements and feedback.

Group 1 chose to spend some time standardising the look of their site using templates in order to provide a clear structure within which each pair of researchers could upload their material to the wiki. This design was carried out by a small group of students, lead by one student who had some web design experience, but the result was agreed upon by the entire group. The group was then divided into four subgroups and the tasks distributed as follows:

- Group a - task (i)
- Groups b, c and d divided task (ii) of researching systems, finding articles and reviewing them by year,
  - group b – years 1998-2001
  - group c – years 2002-2005
  - group d – years 2006-2008
  - some subgroups further divided their work, researching a particular year each.
- For task (iii) one student created the categorised list of airborne sensors and individuals from groups a-d researched and reviewed literature on selected sensors.

Group 2's approach was very different in that:

- Two students took the role of coordinators and set up the design of the site
- One individual addressed task (i)
- One individual produced the list of spaceborne sensors
- One individual produced the list of airborne sensors
- The rest of the group then chose one sensor each, carried out the necessary research and produced the review.

3.2 Close Range Photogrammetry (Part 2)

The second part of the module addressed the subject areas of digital image acquisition and close range photogrammetric project execution. In this section four formal lectures and two tutorials were delivered to the students before assigning the group-based task. One of the tutorials guided students through the use of Lisa photogrammetric software (Linder, 2003) for close range projects. The second aimed at improving student research skills through the use of library databases and e-journals and helping students to produce academic quality reviews.

The class was divided into groups of four or five students and the project brief was provided to the students in the form of a Request for Tender (RFT) for 3D close-range photogrammetric measurement of the façade of a Georgian building (each group was assigned a different building on the same street). In the first stage (one week) the groups produced a tender addressing all photogrammetric elements with the exception of costs. The tender also included an evaluation of why stereo photogrammetric techniques were used in preference to bundle block methods. This evaluation was based on reviews of current research and best practice. The tenders were produced via collaborative writing on the same wiki sites as had been used previously. Each group then discussed the tender with the lecturer and were provided with feedback before proceeding to the fieldwork stage. Images were captured using a Nikon D70 with a Nikkor 18-70mm lens. Natural control was used due to issues of access and safety and measurements were made using a Leica 1205 5" reflectorless total station.

After processing, students produced a stereo model, 3D vectors and a surface model of the façade. Each group then produced a project report, again written collaboratively on the wiki site, analysing the quality of their results and evaluating their work in relation to alignment with the original RFT. The report was submitted and each student group made a short presentation to the class and lecturer on the process and results achieved. As before, in order to ensure that students achieved all learning outcomes and did not just focus on a portion of the task (depending on how work had been allocated) an individual interview was also carried out at the end of the project. Assessment was again divided between group (~20%) and individual (~80%) elements with even less chance in this portion of the module of an individual being able to hide behind the achievements of the rest of the group.

4. RESULTS

At all stages of the module the lecturer recorded their own reflections on progress, both of the project in general and of individual students. The notes collected also included informal feedback received from individuals or groups of students. At the end of the module students were provided with a feedback form which collected information on:

- The quality of the overall module (this section replaced standard quality assurance procedures in place in the DIT)
- Previous knowledge of and perceived utility of Web 2.0 concepts in an educational context
- Perceived value and difficulty relative to other modules on the programme
- Support structures for the modules
- General elements and suggestions for improvement

Only 23 of the 38 students actually returned the feedback form. This was despite informing the students that evaluation of the success of the module delivery format was ongoing and that their feedback would be critical to making a decision about continuing in the new format. The author feels that this makes its own comment about the levels of engagement among some of the class and the difficulty in gauging the success of any initiative, from the student perspective.

4.1 Issue 1: Group Size

At the end of part 1 a discussion session was held with the full class to identify and resolve issues that had arisen and prevent them from interfering with the achievement of the learning outcomes of the rest of the module. The main complaint related to the size of the groups and the difficulty in organising and creating equal workloads for 19 people. In the feedback forms 87% of the students agreed that it was necessary to impose a more definite structure on the large group work (e.g. appointing a team leader, rotating roles, etc.). With this in mind and due to the nature of the second part of the project the decision was made to reduce the group size to 4-5 individuals. This issue did not arise at the end of the second part.

4.2 Issue 2: Shortage of Time

Another comment that was returned by the majority of students after part 1 was that they did not feel that they had enough time to complete all of the assigned tasks. A number of reasons can be given for this issue:

- The author accepts that the range of the initial task was too broad. During part 1 the task was redefined to require only information about satellites from the US, Europe, Russia, India, China, Japan and the Disaster Management Constellation.
- The problem was exacerbated by:
  - the duplication of a lot of work by the students due to a lack of interaction with the social bookmarking and social citation sites;
  - the division of the tasks, particularly by group 2, meant that some students could not start to work until others had completed their sections; and

- poor communication between members of the groups even though separate discussion forums were set up for each group on the module's WebCT site.

Less than 10% of the students posted material on either the social booking or citation sites. Most also preferred to collate their research material using Microsoft Word and then transfer it into the wiki, despite the site's WYSIWYG editor being adequate for the task.

Based on the amount of non-education-related student access to the internet at DIT, and as is reported at educational institutes worldwide, these findings were a surprise to the author. When asked on the feedback form 78% of students responded that they had used sites with Web 2.0 elements, with Bebo being the dominant site listed. The expectation at the start of the project had been that students would immediately identify the similarities between the wiki, social bookmarking and citation sites, and the social sites that they regularly used for viewing videos, chatting with friends and posting comments. It was hoped that having identified these parallels the students would utilise the Web 2.0 sites and see their educational and group-work benefits after receiving only a basic demonstration/instruction set. This reapplication of knowledge did not occur for the majority of students. Therefore prior to the start of the second part of the project an interactive tutorial was held where students were guided through the use of all three Web 2.0 tools, and where a set of del.icio.us tags (words used to describe or relate bookmarks) were defined for each group.

4.3 Issue 3: Interviews & Research Skills

Unlike in many continental European higher education establishments, the predominant form of assessment in Ireland is through written project or examination work. Students, therefore, are typically not practiced in the skills necessary for the preparation for and successful completion of an examining interview. Thus, the average score in the interview after part 1 was only 42%. While a small number of students preformed poorly at the interview due to nerves and a lack of familiarity with the process, in general, the poor results were due to a lack of preparation. Although students had been informed at the beginning of the project that the individual interview would examine their understanding of the formally taught material, the content of the wiki and their own contributions, many did not seem to have even a vague notion of anything beyond their own small task, and many could not explain the gist of the articles that they had reviewed. This revealed that for many the review was an exercise of "cut-and-paste" with some variation in words but without any effort to comprehend the contents.

Prior to the start of the second part of the module the interactive tutorial also addressed the issues of academic research using a range of library databases, journals (including the International Journal of Photogrammetry & Remote Sensing) and research body websites (including isprs.org). Guidance was also given on writing reviews and using bibliographic software (DIT provides access to EndNote for all students) and students had the opportunity to submit material for checking in order to receive feedback.

The interviews for the second part of the module were scheduled for two semester weeks after the student presentations and the deadline for completion of the submitted reports. In reality the gap was actually longer as it stretched over the two weeks of Christmas holidays but students were engaged in written examinations for 5 other modules. Therefore, as a result of being in examination mode (and thus putting more effort into preparation) and having experienced one previous interview the average grade for the interview increased to 54% for part 2. The second interview was longer and more in-depth than the first which, perhaps, account for why students did not perform significantly better. The average grade for part 2 including all group and individual elements was 65% which aligns well with the widely reported improvement in results caused by team work.

5. FUTURE IMPLEMENTATION

From the verbal and written feedback from students there was general agreement that moving away from delivery via standard lectures and assessment by written examination was a good idea. 74% of the class recommended running the module again in the 'different' format but most suggested changes, particularly for the first part and generally in relation to time. Only 2 students said that the module should return to the old format and one of these commented that it was not because of the module but rather because they did better at examinations than at project work. Four students did not answer the question; perhaps because it was the last one on the questionnaire. The author interprets this as meaning that if these students do not have a preference then the experiment was not unsuccessful.

5.1 Other Measures of Success

It must be noted that while the module can be seen to be successful based on student feedback it is also important to measure these results by a number of other means. Two of the original motivations for the change were the need to improve both student attendance and student grades. Table 1 illustrates the average attendance rates for the Remote Sensing module in each of the last three years (including this year's new format). Table 2 shows the average grades achieved for the same period.

Year	**2005**	**2006**	**2007**
Average Attendance	60%	70%	80%

Table 1 Average attendance rates per year

Year	**2005**	**2006**	**2007**
Average Grades	46%	44%	62%

Table 2 Average grades per year

Obviously one cannot draw too many conclusions after only one delivery in the new mode but first results are promising. In particular, the increase in student grades is very encouraging. Fullan (1993, p. 17) warns against "drawing conclusions" from initial results without being "patient enough to learn more about them" and also looking for "the longer term consequences".

Perhaps the more critical factor, however, relates to the influence that the new mode of delivery might have on subsequent remote sensing modules. As mentioned previously, the decision was made to continue delivering the Remote Sensing II module in the standard mode of weekly lectures plus small group practical classes once every few weeks. At the time of writing students have taken approximately three-quarters of the lectures for Remote Sensing II. It is the lecturer's impression that the level of understanding and involvement in class seems to have improved upon previous years.

Further proof of success will only be available after the end of semester examinations and it will only be possible to fully gauge the results after a number of deliveries and a detailed evaluation. Also any students who undertake work placement in remote sensing-related practices will be monitored closely in order to produce a further critical measure.

5.2 Changes for the Next Delivery

Part 1 (Remote Sensing Systems & Applications) will change significantly while part 2 (Close Range Photogrammetry) will remain essentially the same. The first change will be that the students will start working on their own tasks immediately. This year there was a gap of two weeks before engagement leading to a shortage of time at the end. The groups for task one will be reduced in size. This will be supported by a new development on the pbwiki site whereby access control can be executed at page level, rather than only at site level as was the case this year. Consideration will also be given to the idea of assigning leadership roles, although with the smaller groups this is less necessary.

The interactive tutorials delivered between parts 1 and 2 will be provided at the beginning of the module which should ensure higher standards from the outset. Consideration is also being given to a change in the timing of the individual interviews so that the act as a formative, rather than a summative, assessment.

This year, although the pbwiki tool has the facility to produce portable document format versions of the content it was not used. In the next delivery the end product for the students will not only be the wiki site but also a pdf version which can form part of their portfolio shown to programme external examiners. The portfolio can also be used by students in job interviews or for other personal capacities.

For 2007 an extra time allowance was available to the lecturer via a grant made available by DIT's Learning & Teaching Awards. Since this allowance will not be available for further deliveries consideration will have to be given to how sufficient resources can be made available in order to provide the necessary support and feedback to students.

5.3 Conclusions

The experimental delivery of remote sensing supported by a range of Web 2.0 tools was a success. The new mode of delivery and assessment will be used for future deliveries of the module Remote Sensing I and may be extended to later modules in the Geomatics programme. However, there is still significant room for improvement in some elements of the delivery and a number of changes, as described in section 5.2, will be made for the next delivery.

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