Action Research for a New E-Learning GPS/Surveying Platform

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SUMMARY

In order to assist the surveying industry face unprecedented international economic, environmental and governance challenges the educational challenges of the GPS/Surveying discipline need to be confronted. These challenges centre on the alignment of curriculum and assessment with new technology tools to overcome conceptual and technical complexity in teaching and learning. The result will be graduates who are better equipped to apply work ready knowledge and skills to solve critical problems in a global context.

Like RMIT University where the action research project outlined in this paper was undertaken, all international universities are striving to produce graduates able to meet the burgeoning needs of the surveying sector operating in the international market.

The GPS/Surveying team at RMIT is a key education provider in Australia for both higher education (HE) and technical and further education (TAFE). Since 2007, the GPS/Surveying team undertook a three-year action research project to redesign the GPS/Surveying curriculum across a number of university programs. The redesign has focused on an industry-based problem approach interfaced with a new web-based multimedia learning tool. This has sought to address limitations presented by discipline complexity exacerbated by conventional classroom resources and teaching and learning (T&L) methods. A new E-learning platform for GPS/Surveying has been developed through the project. This paper describes the project's rationale, objectives, methodology, development stages, outcomes and evaluation. Key stakeholders of the university and surveying industry, as well as student input in the development of the learning tool that has been critical to the success of the project. This collaborative project model between the education and industry sector points the way forward for achieving the ends of the surveying industry in playing a central role in assisting business and government to build capacity to face global challenges.

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1. INTRODUCTION

Many key concepts related to GPS/Survey, such as rotation, coordinate system, datum, and satellite signal propagation are very difficult to teach, learn and apply, due to their multi-dimensional and dynamic characteristics (Aydin & Kaptan, 2008; Jaksa, James, Davison, & Toll; Zhang, Fu, Zhou, Demathieu, & Wu, 2007). Conventional two-dimensional and static media such as paper or whiteboard are very ineffective to represent the multi-dimensional and dynamic spatial relationships underpinning these difficult concepts, in both educational and operational contexts. Moreover, rapid developments in information and communication technology (ICT) and globalization are creating new challenges and opportunities for the industry sector and consequently for universities attempting to produce work ready graduates.

Leading educators and researchers have developed or are developing relevant teaching and learning tools based on the new technologies and the web across a wide range of disciplines (Clare & Judy, 2009; Clark & James, 2005; Pepper, 2009). These include GPS/Surveying to advance many aspects of pedagogy to meet industrial applications in a globalized context. International universities are striving to produce graduates with what has been termed by some as a "global passport" to meet the burgeoning needs of industry sectors operating across national boundaries.

The Royal Melbourne Institute of Technology (RMIT) University in Australia is a global university with several international campuses hosting over 18,000 international students from more than a hundred countries. The geospatial discipline at RMIT is a key education provider in Australia for both higher education (HE) and technical and further education (TAFE). It covers the fields of global navigation satellite systems (GNSS), surveying, geodesy, remote sensing and photogrammetry, geographic information systems, and cartography.

The GPS/Surveying team in the discipline is one of the longest-running and largest GPS/Surveying course based education and research groups in Australia with international reputation. Since 2007, the GPS/Surveying team has undertaken a three-year action research project to redesign the GPS/Surveying curriculum across a number of university programs. The redesign has focused on an industry-based problem approach interfaced with a new web-based multimedia learning tool to address limitations presented by discipline complexity and available classroom resources and teaching and learning (T&L) methods. The project has been implemented and evaluated in three stages, to develop and evaluate 1) a wiki platform, and an interactive concept map; 2) a web-based 3D/4D animation tool for T&L; and 3) a prototype of assessment and feedback based on inputs from industries and students.

The paper firstly discusses the challenges of GPS/Surveying education. The new GPS/Surveying T&L platform developed by the research team is outlined. This is embedded in the team's practical educational expertise drawing on relevant pedagogical research and in close collaboration with both internal T&L groups and industry networks. The project's objectives, methodology, development stages, outcomes and evaluation including student and industry feedback are discussed. The paper concludes with the major outcomes of this action research project and highlights future research questions and applications.

2. MAJOR CHALLENGES IN GPS/SURVEYING EDUCATION

There are three key stakeholders in the GPS/Surveying discipline whose perspectives and needs have been factored into the design of the action research project, namely the students, industry and the university. RMIT University like other teaching and research institutions is committed to foster a T&L environment that optimizes the potential of students to develop work ready skills. These conceptual and technical capabilities must be addressed across different levels of graduates from TAFE, HE course work and research to meet a variety of industry needs. Finding better technical, business and human resource solutions to increase productivity and economic growth and sustainability was identified as the core industry need. Competent graduates are critical to meet these industry requirements. Therefore, producing knowledgeable and skilled students for industry is a high priority for universities. GPS/Surveying related sector also are taking responsibility for working with universities to assist in making course work and research processes more relevant for students.

There are two key capability sets essential for student development in the geospatial discipline. One is the conceptual understanding of the theoretical principles underlying tempo-spatial relationships. The second set is related to technical competency to meet the industry's high dependence on the use of Information and Communication Technology (ICT). Scientists, engineers and technicians working in this discipline are required to have a highly developed ability to integrate the conceptual tempo-spatial understanding and IT skills to effectively address industry needs. The level of complexity of mathematical models and the volume of data processing involved challenge both the teachers and students in the T&L practices, especially under the lecture and whiteboard based environment.

GPS has experienced very rapid and significant technological development in the past decade and the instrument operations, techniques and data processing in practical components have accordingly changed significantly. Surveying has been a leading industry embracing GPS technology since GPS's earliest development and has grown and changed with the revolution of this technology. Alongside the changing industry, universities have been challenged to keep up with the latest technologies. This technological revolution has resulted in transformational changes across the organizational structures of universities and industry and in the way they respond to the delivery of their services. It has also resulted in significant changes to the everyday lives of people. Emails, digital teaching tools and the growth of a web-based learning environment are familiar to the experience of students and teachers and have been adopted by universities into the design of curriculum and assessment. Young people are comfortable with new communication technologies such as iPhone, Blogs,

Facebook, podcasting, virtual environments and online games. Embedding these new technologies in T&L practice is an important challenge and necessity for universities. It opens exciting opportunities to attract both local and international students through a more robust, relevant and engaging learning environment. This extends also to worldwide education consumers via more flexible platforms, i.e. online programs.

The growth of the international education market through globalization and technology revolution has created abundant options for industries and universities to partner each other for enhanced student learning. Graduates need to have learning experiences that refine their capabilities to work in globalized industry where they will compete with worldwide candidates. In this sense, industry, the university and students have a common interest to face these international challenges and make the most of opportunities. The action research project to develop a new E-Learning platform has been a response to these challenges and anticipates it will broaden the opportunities for students in the GPS/Surveying industry sectors.

3. RMIT RESPONSES TO THE CHALLENGES

International students constitute 35 per cent of the RMIT University cohort, which is situated in the urban heart of the multicultural city of Melbourne. The university has developed an international reputation as a world-class provider of application focused technology education and produces graduates with a "Global Passport" or competency set to work for globalised industry. RMIT articulates its mission as being to "create and disseminate knowledge to meet the needs of industry and community and foster in students the skills and passion to contribute to and engage with the world" (RMIT-University, 2009). Strategic initiatives or priorities designed to achieve this mission include the global passport, work integrated learning, industry engagements and a learning ethos committed to urban studies, research excellence, creativity and innovation. The overarching goal is to prepare graduates who are work-ready so that they are equipped to apply their skills and knowledge to solve real-world problems in a global environment. This is particularly relevant to the public and private sectors seeking employees, who are able to process, analyze and apply satellite data using the latest technology platforms to address industry needs.

Satellite positioning and surveying are two core contents of geospatial education across a number of RMIT University programs, including Advanced Diploma of Spatial Information Services, Bachelor of Applied Science (Surveying, Geomatics and Cartography), Graduate Diploma and Masters by course work, Masters by Research and PhD. There are seventeen Global Navigation Satellite Systems (GNSS) and surveying related courses at RMIT University. The GPS/Surveying team, responsible to the GPS/Surveying education and research in RMIT, responding to the university mission are to redesign the courses by integrating more industry oriented components and reviewing the course practices. The research undertaken is supported through the College Action Research in T&L (ARTL) in 2007 and 2008, and the RMIT Learning and Teaching Investment Fund (LTIF) in 2009. Collaborations with internal university groups have been formed to ensure the success of the research project which has worked with the College teaching development group and the university's Educational Media Group. A key external partner in this project has been the

Victorian Department of Sustainability and Environment. These internal and external collaborations have been leveraged to enhance the student learning experience and outcomes through engaging innovative, useful and usable technology.

This research addresses the following three challenges - discipline complexity, the technology revolution and globalization. For the students this has been the design of a new curriculum approach around working on industry problems using the multimedia tools to enhance critical thinking and effective communication. The student learning outcomes will benefit their long-term professional development and readiness for industry. The close project partnership between the university and industry has identified opportunities to use this same industry problem and multimedia approach in workplace training to enhance professional standards and industry certification.

The project team's educational and research expertise built since 1930s has contributed to the prototyping and evaluation of the new T&L Platform through recent action research project using the latest IT and Web technologies. These technologies are wiki, flash, multimedia, blog, forum, database and simulation. The platform using these technologies supports the key stakeholders in four ways, which is summarized in the Figure 1 below.

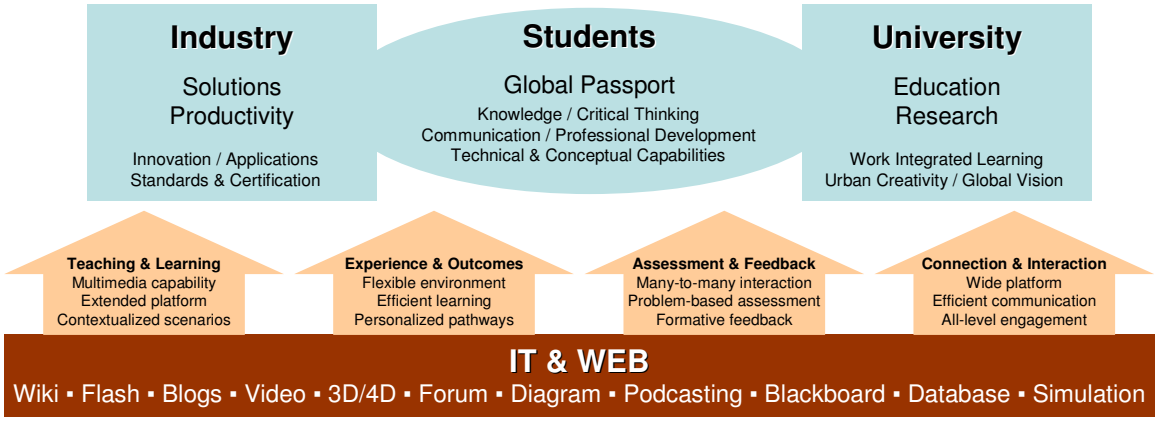

Figure 1. The new e-learning platform supports the three key stakeholders in four ways

Firstly, research and development of computer-based and more recently web-based T&L are conducted worldwide to overcome the limitations in the traditional lecture-centred education and training practice (Chutima & Vipa, 2006; Don, 2003). Contrasted with conventional education methods using static tools the IT-based systems have many advantages. These include multimedia capability with broader, flexible and low-cost accessibility, easy manageability and the capacity to customize for different contexts. With the aid of the computer and the web, lecturers can perform better delivery of knowledge. For example, the digital demonstration of learning materials not only saves valuable lecture time but also illustrates complicated concepts and knowledge structures in advanced methods in easily understood ways, e.g. three dimensional model and animation in the geospatial discipline.

Most computer-based teaching systems are learner–centred allowing the student to work at their own pace with individually relevant feedback for better assessment outcomes (Dong &

Hubble, 2004; Fisher, King, & Tague, 2001). The flexible delivery of learning (time, location and content) allows students to access it outside of the classroom. It can further be customized to suit the students' level of ability or type of degree or diploma program.

Moreover, assessment and feedback framed around industry problem develops individual work oriented capabilities. Digital and online assessment tools aligned to work integrated or industry projects provide an advanced platform for self and group assessment and feedback. Formative feedback and individual performance responses tailored to individual student needs enabled the multimedia system are valued by the student (McConnell, et al., 2006; Nicol & Macfarlane-Dick). Group learning based on the blog and forum systems will be much more enjoyable and efficient for students and teachers and foster greater peer interactivity. Internet services also provide teachers and learners a communication platform for connection and interaction in a worldwide context across all levels. This system will create an additional channel for connection between industry, lecturers and students.

4. METHODOLOGY AND RESEARCH TO DATE

In 2007, the GPS/Surveying team initiated the project through the Action Research in Teaching and Learning Scheme (ARTL) offered by the College of Science, Engineering and Health, RMIT University. The project was further developed through funds from the same scheme in 2008 and an RMIT University grant in 2009 to generate industry based problems for assessment and integrate these with the earlier multimedia developments. Each stage of the project addressed different pedagogical strategies to engage students and enhance the attainment of conceptual understanding and technological skills

4.1 Stages one and two

The main the first stage of the project developed rich IT-based and web-based resources to be used in the TAFE and HE sectors enhance teaching resources for satellite positioning, surveying and geodesy related courses. An innovative prototyping system to enhance students' learning by assisting them conceptualizes all the interconnecting elements through a mind map and contributing their reflections through a wiki was developed.

The successful implementation of the 2007 project resulted in the team receiving a second stage grant through the 2008 ARTL Scheme. The 2008 project focused on the further developing the multimedia tools to enable integration with the online system. The aims of the 2008 project were to 1) to enhance students' leaning experience and outcomes with the help of multimedia (photos, videos and 3D/4D animations) visualizations, selected Internet resource hyperlinks and enhancing the mind map tool, and 2) to improve information-sharing and collaboration between teachers of different courses to foster innovative approaches to using learning technologies in the classroom. The main products of this project were eight 3D/4D animations that visually demonstrate the complex concept of satellite orbit and positioning techniques in an easy to follow way. An introductory guide, images and quizzes associated with the animations were produced to help student effectively use these animations for their learning. These were integrated with the customized mind map and wiki platform.

Our research has confirmed the use of 3D animation technologies aids the representation and comprehension of complex multidimensional space and time relationships and overcomes the limitations of the traditional two dimensional paper sheets or white boards. The approach to designing educational animations and simulations using Macromedia Flash and Java Applet was informed by pre-project research that recommended their effectiveness in assisting students to understand complex and critical information related to GPS. This was especially helpful in visually representing satellite concepts and relations (Aydin & Kaptan, 2008). For example, a interactive representation graph (Figure 2) has been developed to demostrate the fundamental satellite orbit information by using the web-based Flash technique. It contains much more information than the stastic media (i.e. whiteboard) and offers better learning accessbility and experience to students.

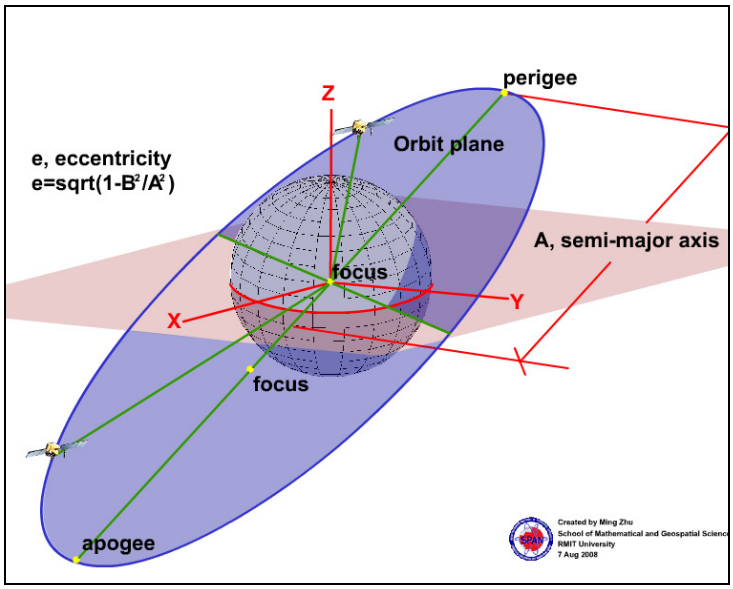

Figure 2. Interactive representation graph of the key satellite orbit concepts

Through the 2007 and 2008 ARTL projects, an interactive online T&L system and a number of multimedia learning tools were developed. Positive feedback from both students and staff was received during the project evaluation. It showed that the interactive animations, readily available web information and effective mind map structure will improve student's learning practice and increase the efficiency and flexibility of delivery. Project outcomes were presented in a Science, Engineering and Health College L&T workshop and at an international GNSS conference. The projects approach and outcomes were well received by academic staff and the international GNSS community.

4.2 Stage three

The team also addressed the complex multi-dimension challenges in relation to assessment in the discipline of geospatial science. In 2009, the project received university level funding through the Learning and Teaching Investment Fund (LTIF) Scheme. The aim of the third

stage was to investigate the prototyping of an assessment and feedback framework for a 3D/4D multimedia learning tool based on industry and student inputs. It was hoped that this framework would enhance student learning across a wider range of practical settings and therefore develop higher level problem solving skills and work readiness. The rationale being to tightly link university T&L activities with real world scenarios (e.g. relevant and engaging applications, current R&D activities, and the latest information provided on the internet by various industries, government, research organizations and universities).

This was achieved by identifying a range of industry-focused situations and contexts for the applications of this discipline. A bank of simulations and case studies were developed based on industry and practitioners' needs. Students across different levels of background, experience and knowledge were encouraged to contribute to the development of this bank. A range of problem-based questions were generated based on both industry and student inputs i.e. key stakeholders who would be using the technology. These questions were incorporated into formative and summative assessment processes. This framework provided the interface between underlying knowledge, technology skills and problem-based learning.

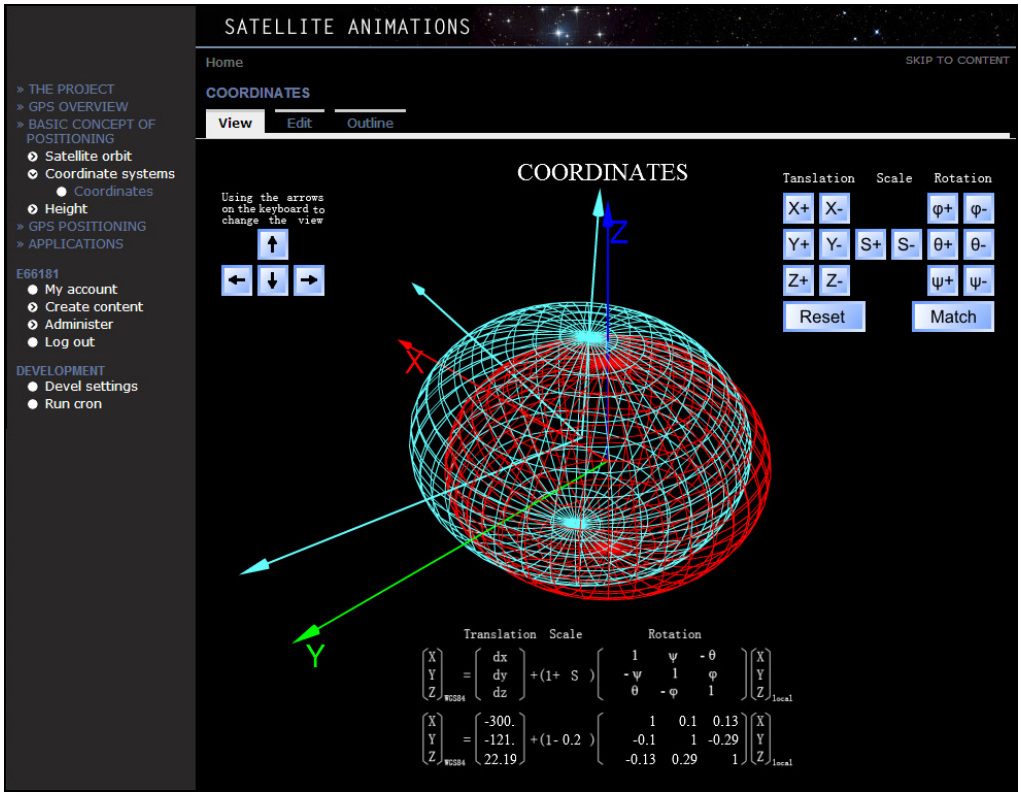

Figure 3. Coordinates transformation learning tool

Project goals were aligned with industry engagement and work integrated learning policies of RMIT University. This project is beneficial to Victorian geospatial and other related industries by supplying graduates updated with the latest enabling technological and industry developments, including the GNSS technology. Graduates would be expected to enter the work environment more confident and competent in their applied skills. Framing problem-

based assessment with industry inputs to make the most of the 3D/4D multimedia tool helps raise the standard, reputation and employability of RMIT graduates. Transformation among different coordinator systems is often required by industrial practices. It is difficult to teach and learn due to the complexity of the spatial relationships and mathematical models. A self-assessment learning tool (Figure 3) has been developed to ease this problem. Students are able to see the visual and mathematical representations of the transformation directly while adjusting the parameters.

Customising the assessment to different student's needs and knowledge levels will offer the potential to provide elective courses utilizing this learning tool and assessment approach to students with related academic and professional interests in other RMIT colleges. Encouraging industry and student engagement at the design stage of the assessment framework may offer a model for new assessment and feedback approaches for complex fields across the university. Industry response suggests that it would be a good return on investment to embed this learning tool in curriculum by attracting more students seeking relevant and practical learning experiences to find work opportunities.

The online T&L system is currently being integrated with the RMIT web system. It will be publicly accessible via the RMIT website (http://emedia.rmit.edu.au/satellite). An addendum reviewing the three year action research project outcomes and evaluation will be included with this paper on completion by the end of this year (2009).

5. CONCLUSION

This paper highlights the current challenges facing the GPS/Surveying discipline due to issues of conceptual and technical complexity, rapid technology changes and competition in a globalized workplace. It addresses these issues by outlining the goals, methodology and outcomes of a three year action research project to deliver a work integrated e-learning platform. Industry, the university and the students are the key stakeholders of the project sharing a common interest to face these international challenges and seize new learning and work opportunities.

The e-learning platform contains (1) a wiki system, and an interactive concept map; (2) a web-based 3D/4D animation tool for T&L; and (3) a prototype framework of work related assessment and feedback based on inputs from industry sectors and students. The research outcomes and feedback from students, teachers and industry have demonstrated the potential of advancing the GPS/Surveying education by using the latest IT and web technologies.

The next step will be the introduction of the system into actual class learning and assessment activities in 2010 across a number of courses identified to pilot the project. This will refine and enhance the system before a roll out across all geospatial courses at RMIT University in 2011. Opportunities for collaboration to explore customization of the product with other universities in Australia and overseas, as well as a government department and some industry groups will be pursued.

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