Flexible Delivery of Education in the Spatial Sciences

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ABSTRACT

Spatial sciences programs are characterised by a diverse range of subject offerings and emanate from within several discipline areas. Departments of surveying, cartography and geography are the main providers of spatial sciences education, however, business and computing now also participate in GIScience courses. The clientele of education in this specialist area is becoming more diverse, as are the providers and the modes of delivery and participation.

Along with this growth and development of educational programs in the spatial sciences comes the need to provide flexibility in their delivery. Flexible, open and distance education strategies are being focussed on learners from a range of backgrounds and with a variety of requirements. These learners require access to an education that is sufficiently flexible to suit their needs and geographic location.

Information technology can play a crucial role in providing flexibility for spatial sciences education. This paper focuses on the spatial sciences programs at Curtin University where web-based technology is being utilised for on-campus, distance and flexible modes of delivery.

INTRODUCTION

The nomenclature applied to educational programs in the spatial sciences area in recent years reflects the continued development of this diverse field. Cartography, multimedia cartography, geographic information science, geomatics, surveying, land information and spatial science are all used to describe educational programs that encompass all or part of this specialised area. Programs are characterised by a common *core*, but exhibit considerable diversity dependent upon professional requirements, staffing, physical resources and historical development.

While departments of surveying, cartography and geography are the main providers of spatial science education, business and computing are rightfully taking their place in the provision of geographic information science (GIScience) courses. This expanded catchment involves a far greater number of potential students, but further fragments an already moderately-sized market. One of the challenges is to link student demand on a local, national and international basis with appropriate educational programs. This is further exacerbated not only by the diversity in programs offered, but also by the different requirements of the wide range of career opportunities available and the specific skills required (Kemp and Unwin, 1997; Forer, 1997).

Consider, for example, geographic information systems (GIS). GIS are used across a wide range of disciplines including cartography, surveying, geography, computing and information technology, geology, environmental science, urban and regional planning, business management, among others. Applications can, for example, range from the measurement and collection of

spatial data for asset management, to the analysis and modelling of population distribution and growth patterns in urban planning. The implementation of GIS and the skills required can vary considerably across these areas. Further, many potential GIScience students may already have a background or have developed skills in one or more of these areas. Because of the diversity among GIScience learners, the programs offered must take into account their background and how they are able to utilise GIScience within their chosen career.

The explosive growth of the World Wide Web and online technologies has opened the way to facilitate the delivery of flexible learning programs (Wilhelm and Friedemann, 1998). *Flexible learning* encompasses both the traditional style of delivery (eg. lectures) and individually negotiated learning activities, in addition to everything in between (Thomas, 1995). Flexible learning brings together the learners (and their needs), the learning resources (including instructors), and the technology to deliver and facilitate the learning program. The GIScience program at Curtin University is an example of a proactive approach in which a flexible learning environment has been developed to accommodate both on-campus and distance learners.

NEW EDUCATION CHALLENGES

University education worldwide is subject to a range of challenges resulting from the rationalisation and globalisation of the education market. Rationalisation of education systems by national governments is resulting in more focused funding models and promoting a drive by universities to deliver additional funding from external sources including fee paying students, research contracts and consulting. Additionally, universities are examining their own operations and identifying efficiencies in service delivery to reduce the unit cost of their operation and to improve the learning experience for the students.

Shortis and Cartwright (2000) identify the following as the main drivers for the introduction of new teaching and learning methods. There is a developing awareness of the volume and complexity of the available information in most disciplines, and recognition that it is impossible to achieve optimum delivery through conventional teaching approaches. In comparison to courses in commerce, law and arts, science and engineering courses are considered to place too much reliance on face-to-face contact with students. Mechanisms need to be investigated to decrease the reliance on structured class teaching. Additionally, the rapid increase in student enrolments highlights the need to more effectively utilise the teaching resources for content delivery and course management.

Globalisation of education resulting from development of strategic alliances between education providers, joint venture agreements to provide for the development of education facilities and competition for international students, are all influencing the delivery and management of university courses. The growth of online learning and development of the e-university concept in many countries represents a logical response to these actions. With an estimated global Web education market in 2000 of $US60 billion, and the announcement by the British Higher Education Council for a planned $US500 million expenditure on an e-university initiative (Milton-Smith, 2000), substantial investment is being made world wide in alternative online learning and course management strategies. Both Oxford and Cambridge Universities in the United Kingdom have developed partnerships with leading US universities to develop online and flexible education capabilities.

Commitment to e-learning alone is not sufficient to maintain pace with globalisation of higher education. Acknowledgment of appropriate implementation strategies must be made to provide an environment for effective product development. Shortis and Cartwright (2000) indicate six

delivery strategies, however reference and resource materials, information portals and computer-mediated communications provide the fundamental building blocks for effective online and flexible delivery.

Reference and resource materials are designed to provide the same facilities online that are presented via lectures and tutorials, and are available in a standard university library, as well as other resource materials such as software and data sets, all delivered to the students' desktop. *Information portals* provide access to online resources for content delivery and course management. Increasingly important, the information portal manages security issues and protects course content and reference materials from infringement of copyright. As digital copyright regulations become more stringent, development of secure portals is essential. Online learning provides the opportunity for multiple *communications* between students and tutors. Discussion forums, mediated discussions and chat rooms are now possible, and add a further dimension to the experience.

SPATIAL SCIENCE EDUCATION AT CURTIN UNIVERSITY

Education in the spatial sciences at Curtin University has evolved from an amalgam of courses within the surveying and cartography, and information technology disciplines. Over several decades, individual courses in surveying, cartography and GIScience have been developed to the stage where each occupies an important place in the education, training and research profile of the spatial sciences industry in Australia. Pullar *et al* (1998) cites a similar evolutionary path for GIScience programs at the University of Queensland, however the outcomes have been quite different. While in Queensland the focus has been on graduate programs, Curtin University has developed a comprehensive range of programs from undergraduate (including double degrees), through to graduate coursework and research degrees. A list of these programs is provided in Table 1.

Bachelor of Science (Cartography)
Bachelor of Science (Geographic Information Science)
Bachelor of Social Science/Bachelor of Science (Geographic Information Science)
Bachelor of Science (Geographic Information Science)/Bachelor of Science (Applied Geology)
Bachelor of Surveying
Graduate Certificate in Geographic Information Science
Graduate Diploma in Geographic Information Science
Graduate Diploma in Remote Sensing and Land Information
Postgraduate Diploma in Geographic Information Science
Postgraduate Diploma in Surveying and Mapping
Master in Geographic Information Science (Coursework and research)
Master in Surveying and Mapping (Coursework and research)
Doctor of Philosophy

Table 1. Spatial sciences programs available at Curtin University

Surveying and cartography courses have developed in conjunction with the relevant professional areas, while GIScience has been in the unique position of also being part of a rapidly evolving discipline. The development of GIScience programs at Curtin University has resulted from a strong IT influence. These origins are reflected in the core studies that provide a

thorough understanding of the theoretical and practical aspects of the structure, development, application, implementation and management of GIS. Studies in the areas of mathematics, statistics, cartography, remote sensing, spatial analysis, spatial modelling, spatial data collection and cartography are supplemented with core IT units in software technology, software engineering, operating systems design and database management. This approach sets the GIScience courses apart from many other similar programs in the spatial sciences, in that students graduate having extensive knowledge and experience with mainstream IT principles.

The capacity to offer GIScience programs in distance and flexible learning modes has also received recent attention. Curtin University had made only limited distance education offerings in the spatial sciences area since the 1970s, but has recently devoted significant resources to the development of relevant distance and flexible learning materials for GIScience.

FLEXIBLE LEARNING REQUIREMENTS

The importance of flexible education has increased with the advances and expanding use of technologies (Boyd *et al.*, 1999). Greater emphasis has been placed on the learner who is able to access learning technologies to help them make informed choices concerning how they develop their knowledge and skills.

It is, therefore, important to understand the needs and requirements of learners so that the appropriate technologies and resources are accessable. Although the individual needs may vary, there are a number of relatively common learner needs that can be identified (NIE, 1979; Bacon, 1997):

- *Need for appropriate learning methods and flexible delivery*. The needs can vary among learners and involve classroom instruction, practical laboratory sessions, workshops, tutorials, independent study, individual learning, group-based learning and fieldwork. The needs also vary among on-campus and distance learners (Tait and Mills, 1999). Particularly in the GISciences, there must be an appropriate balance in the delivery of the fundamental concepts and also the practical skills. In addition, because of their diverse backgrounds, students may have different starting points in the curriculum and may require variable study paths through the learning material (Marland, 1997).
- *Focus and guide to content and practical work*. Students need to know their objectives and where they are headed within their study program. It is important that they are able to identify outcomes, navigate their way through content-based materials, and maintain their orientation relative to other topics and components of their study program. This is particularly important in fields such as GIScience, which contains a diversity of concepts and applications.
- *Interaction among peers and instructors*. Interaction is an important component of learning. Students want to be able to interact with their lecturers and tutors in order to ask questions, exchange ideas and seek advice. Students also need to interact with each other as they together build up their knowledge and skills.
- *Responsiveness and feedback*. Within any program of study, students want to know how they are going. They do this by asking questions regarding their progress and work, and receiving feedback either informally or via formal assessment methods. Receiving prompt responses and timely feedback is essential for students to ascertain their progress, learn from their mistakes, and maintain a focus within their study program.

The manner in which these needs are addressed may vary between on-campus and distance students. Distance students who are never on campus and may never meet their peers and instructors face-to-face, may appear to be disadvantaged. However, an advantage that distance

students have over on-campus students is that they are typically more mature, knowledgeable and experienced than the average school leaver (Boyd *et al*., 1999). Also, because of their geographically distant circumstances, they are usually more motivated and are willing to tackle the *distance* problem by making optimum use of the resources that are available to them.

FLEXIBLE DELIVERY FOR GIScience

The traditional three L's of learning are *lectures, laboratories* and *libraries*. All three are interrelated and have served their purpose very well. They are, in general, still used as the main vehicles of imparting knowledge and skills in higher education. However, technology is both enhancing and changing these modes of learning. Multimedia presentation, access to sophisticated GIS software and data, and improved access to reference information all contribute to the enhancement of the three L's. While the focus on content, practical work and information sources remains, there is a shift from the traditional three L's to more student-directed and flexible learning methods.

The Web and Internet technologies have a major role in the development and delivery of spatial sciences programs throughout the world (Fox *et al*, 1999). The differences lie in how and to what extent the technology is being used. At Curtin University, the online resources have been developed over the past 2-3 years for on-campus GIScience students, and more recently, have been extended to fully accommodate distance education program.

In implementing a flexible program for GIScience, the components of administration, content, practical work, assessment, and interaction and support have been identified. At Curtin University, web technology has been used for each of these components to cater for on-campus and distance education students. Where possible, the same components have been developed for both groups of students, but where necessary, separate components have been developed. These components are detailed in the following, and have been implemented using the WebCT course management system (WebCT, 2000).

Administration

The administration of a course includes a wide range of tasks and information required to support the learners and the learning process. The amount of administration for a course depends on the extent to which technology is used. The more the technology is adopted within the course, the more administration is required to provide the *learning framework.* It is relatively simple to use the Web as a dissemination tool to hold materials such as the course outline, textbooks and references, and contact information. However, once the Web begins to be used for more of the learning components, and is used interactively by the students, the administration will expand to involve such elements as the study plan, course navigation, study resources and student management.

Content

The most common method for placing content on the Web is by translating lecture notes using built-in utilities, such as conversion from PowerPoint or Word files. One problem that arises is that lecture notes are designed for face-to-face teaching and may not be readily used by distance students.

The approach taken for the GIScience courses at Curtin University is to enhance, and in some cases replace, the lecture material for online and interactive use. In order to provide a truly flexible medium for the delivery of content, the materials have been redesigned to take advantage of hyperlinks and multimedia. This approach accommodates a multipath curriculum

where students follow the links and navigational aids to bypass material with which they are already familiar, and delve into further detail for topics that are unfamiliar. This caters for a student-directed learning environment where on-campus students can independently support their lecture content with online learning, and distance students can learn the material apart from the on-campus lectures.

The course content has a hierarchically organised index, but is hyperlinked in a non-hierarchical fashion to give the user more flexibility in the sequence of learning. Images are used where possible to enhance the page, make it more appealing to the learner, and assist in the explanation of concepts and terms. The content is arranged in modules which include an index, a list of expected outcomes, a summary, a list of what the student should have achieved cross-referenced to the expected outcomes, and the option of an online quiz attached to the module summary page.

Practical Work

Placing the practical work in a web-based environment is the most difficult task in a GIScience course. Of course, simply placing the practical session exercises on the Web is easy. On-campus students then access them online and implement them by running the appropriate software and accessing the relevant data in the on-campus laboratory. However, making this available to distance students has proven to be a much greater challenge. Firstly, distance students do not have access to the on-campus resources, which often have restricted use based on the software license agreements. Requiring students to purchase their own software (and data) is expensive and cost-prohibitive, and in most cases, not a viable option. Fortunately, there has been an increasing amount of online software and data made available in recent years. Although some of it is only available for demonstration or evaluation purposes, increasingly more software is being made available with defined restrictions.

A unique feature of the flexible learning practical sessions is the support mechanisms available to distance students. For practical sessions in the GIScience area, this may involve technical support for the use of software, downloading and installing software and datasets, interaction and feedback for bouncing around ideas and thoughts in the design and implementation of solutions, use of methodologies and software tools, implementation of GIS within specific applications, etc. In addition to utilising the online technical support contacts for specific vendors and data suppliers, the GIScience program at Curtin University provides tutors who are dedicated to practical session support for distance students.

A further consideration is the field work component within a course. Many of the spatial sciences courses require specialist equipment to be used in fieldwork. Whereas it is not possible in all cases to replace field work with a *virtual* field trip, there are instances when online resources can be used to either simulate the field work event, or be used to supplement the field work component. For example, a trial was conducted in October 2000 within one of the GIScience units at Curtin University where a field trip event (attended by on-campus students), involving data collection and sampling of vegetation, was video taped. The imagery and associated explanatory information were placed on the Web and made available to the distance students, who could *observe* the field trip environment and sampling activities of the other students. Preliminary results from this trial indicate that the distance students were able to grasp the concepts and skills and understand the methods without actually being *onsite*.

Assessment

Assessment and associated feedback have already been identified as important components of a student's learning process. Web technology can be used to enhance the delivery of assessment materials, as well as providing feedback. Student grades also can be recorded and managed online and be released in a timely manner to students.

Within the online GIScience courses, practical sessions and assignments are usually still completed outside of the Web-based environment, although they can be submitted via the Web. This is necessary within the GISciences where problem-solving and solution design skills must be learned in addition to operating GIS software, handling geographic data, and presenting/communicating results and technical reports.

To provide additional and more regular feedback, online quizzes have been developed for both on-campus and distance students. The quizzes are designed to test the student regarding the previous study guide module and practical session work, and to provide feedback to the student. For multiple choice and matching style quizzes, online and automated grading is available so that students can obtain (almost) instantaneous feedback.

Through WebCT, the quizzes can be selectively released to certain groups of students (eg. on-campus versus distance students, deferred submission of a quiz), be available for a limited time period, and have a time-limit imposed.

Interaction and Support

Students require interaction and support as they progress in their learning environment. Electronic mail and electronic bulletin boards are often one of the first technologies provided within an online educational environment, since the facilities are relatively simple to implement and have immediate and significant benefits.

Within the GIScience courses, several modes of interaction have been made available to students. Students can interact privately with the instructor, the tutors or their peers via *email*. *Bulletin boards* provide a broadcast means of disseminating information to students that include calendar tools that broadcast significant dates and times. *Discussion forums* enable students (and staff) to discuss matters of concern to them in a common forum for both on-campus and distance students. A c*hat facility* allows students to interact in real time. Separate *rooms* have been set up for discussing content, practical work or general topics.

Additional forms of interaction can be used for sharing ideas, exchanging viewpoints and presenting student work. These include electronic whiteboards, student presentation areas and individual student web page displays. Because of the significant benefits of the web-based means of interaction, it has become mandatory for all students in the GIScience program at Curtin University to use these facilities. For distance students, the ability to interact with other students (both other distance students and on-campus students), as well as the ability to interact with distance students from other programs of study, is a major factor in bridging the *distance* component of their studies.

THE FUTURE

Curtin University is currently making substantial resources available for development of online course materials and simultaneously implementing IT infrastructure for content delivery and course management. Development of a secure portal will permit efficient management of

copyright reference and resource materials, as well as provide a stable communication environment for students in remote and overseas locations.

The Department of Spatial Sciences is currently undertaking research into alternative delivery mechanisms for technology-based disciplines, such as GIScience, in recognition of online education issues related to courses involving significant components of fieldwork and laboratory experimentation. Funding through the Learning Effectiveness Alliance Program will permit development of alternative strategies for teaching these site-specific and staff-intensive activities. Grants have also been received from the Distance, Online and Flexible Learning scheme for online implementation of additional units in the GIScience programs. The one semester Graduate Certificate in GIScience is currently available entirely by online learning and, in 2002, the Graduate Diploma in GIScience will be fully available by online learning. These developments will enable graduates from any discipline to complete postgraduate qualifications in GIScience without leaving their place of residence or interrupting their employment.

CONCLUSIONS

The use of web-based technology is instrumental in the development of a flexible GIScience learning environment. By taking advantage of what technology can offer, the content, practical work and information components of the learning environment are not only enhanced, but also substantially progressed to focus on a flexible learning environment. This involves a paradigm shift from instructor-based teaching to student-centred learning. Over recent years, the emphasis on the learner has broadened from on-campus students to also include distance learning students.

The paradigm shift to a flexible environment is difficult, particularly in the science and technology areas, which have a heavy focus on laboratory work. The GIScience program at Curtin University has demonstrated that such a shift can be made, through development of appropriate online materials and properly managed and supported implementation.

Web-based content for both on-campus and distance students works extremely well. Distance students spend more time online, whereas on-campus students rely more on formal lectures. Although it does require more work, it is important that the content is not simply the lecture notes placed online, but rather enhanced to facilitate independent learning. In this way, both the on-campus students and distance students reap the benefit.

Finally, it must be noted that the development of a flexible and web-based learning environment does not come without a price. Estimates of 25 to 30 hours of effort per one hour of actual teaching time indicate the commitment required to produce such a course (Winship and Carter, 1998; Cartwright *et al*, 1998; Veenendaal, 1999). Given that time and funding are available, the benefits and results achieved are outstanding. Determining the interaction between teaching and learning in a flexible environment is, indeed, an exciting challenge that is leading the way for the future of GIScience education.

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REFERENCES

Bacon, C. J. (1997) Instructional Design and Pedagogical Techniques for GIS Education in Cyberspace. *Conference proceedings of AURISA 97*, Australasian Urban and Regional Information Systems Association, Christchurch, New Zealand, 17-21 November, ISBN 0 473 04863 9.

Boyd, A., Fox, R. and Herrmann, A. (1999) *Flexible, Open and Distance Teaching and Learning: A guide*. Centre for Educational Advancement, Curtin University of Technology.

Cartwright, W., Fraser, D. and Pupedis, G. (1998) Hypereducation: Prospects for Delivering Region-Wide Cartographic Science Programmes on the Web. *Cartography*, Vol. 27, No. 2, December.

Forer, P. (1997) Flexible Delivery and Social Learning: Seeking a new geography of education for GIS and GIS in education. *Transactions in GIS*, 2:2, Pearson Professional Limited.

Fox, R., Herrman, A., Schrape, J. and Thornton, D. (1999) *Inquiry into Electronic Delivery: Distance Education Enhancement Project Final Report*. Office of Teaching and Learning, Curtin University of Technology, Internal document, August.

Kemp, K. K. and Unwin, D.J. (1997) From Geographic Information Systems to Geographic Information Studies: An agenda for educators. *Transactions in GIS*, 2:2, Pearson Professional Limited.

Marland, P. (1997) *Towards More Effective Open and Distance Teaching*. Kogan Page Limited, London.

Milton-Smith, J. (2000) *Notes from the International Network*, No. 1, Curtin University of Technology.

NIE (1979) *An Evaluative Look at Nontraditional Postsecondary Education*. The National Institute of Education, U.S. Department of Health, Education and Welfare, Washington, D.C., September.

Pullar, D., Sharma, P. and McDonald, G. (1998) A Model for Education in Spatial Information Technologies. *Cartography*, Vol. 27, No. 1, pp. 41-48

Shortis, M. and Cartwright, W. (2000) An Overview of Curriculum Transformation and Multimedia Delivery, *Proceedings of 2nd Trans Tasman, Surveyors Conference*, Queenstown, New Zealand, August, pp.37-49.

Tait, A. and Mills, R. (editors) (1999) *The Convergence of Distance and Conventional Education: Patterns of flexibility for the individual learner*. Routledge, New York.

Thomas, D. (1995) Learning to be Flexible. In *Flexible Learning Strategies in Higher and Further Education*, Edited by Diana Thomas, Cassell Education, London.

Veenendaal, B. (1999) Cyber-learning for GIS: assistant or replacement? *Proceedings of AURISA 99*, Australasian Urban and Regional Information Systems Association, 22-26 November, Fairmont Resort, Blue Mountains, NSW, Australia, ISBN 0 9586233 1 7.

WebCT (2000) WebCT.com: the e-learning hub. http://www.webct.com [Accessed 28 April 2000].

Wilhelm, J. D. and Friedemann, P.D. (1998) *Hyperlearning: Where Projects, Inquiry and Technology Meet*. Stenhouse Publishers, York, Maine, USA.

Winship, J. and Carter, D. (1999) *Alternative Delivery Modes of Teaching and Learning Using New Information Technology*. A Strategic Initiative Project, Office of Teaching and Learning, Curtin University of Technology, July.