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GIS Education at UCOL - From the Teacher Perspective

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ABSTRACT

This paper describes *classroom experience*, teaching the Geographical Information Systems unit within the Bachelor of Applied Information Systems (BappIS) degree at Manawatu Polytechnic trading as UCOL. First the paper summaries the research inspired by the demands of developing the unit: The literature advocates a holistic approach to GIS education - the foremost intriguing question is: is it valid teaching GIS concepts from an IS perspective only? If GIS concepts are being taught in the relative isolation of information systems degree programme, the questions are almost self-manifesting: what topics are covered and what are the influencing factors in designing such a new academic subject? Second, the paper introduces the content and teaching method of the unit, and finally the paper discusses *the learner-centered* classroom experience of teaching this unit between 1996-99.

Keywords: IS & GIS education, learner-centered teaching method

FOSTERING COMPUTING EDUCATION IN NEW ZEALAND

The term *Geographic(al) Information Systems* (*GIS; geomatics* (in Canada), *geomatique* (Francophone)) refers to: “An Information System for providing user with information about objects and features in their geographical contexts. A GIS allows user to display and analyse geographical relationships, and to investigate the effects of changes to locations or characteristics of objects and features that are represented.” (Oxford Dictionary of Computing, 1996:211).

1. INTRODUCTION

This paper presents a classroom experience from the teacher perspective, from the research inspired by the demands of developing the GIS unit, through designing the course content and assessments, choosing the teaching method, and finally delivering the unit.

This author is a lecturer, and in 1995 was designated to create and offer a GIS unit during the second semester of the 1996 academic year. Several intriguing questions had arisen from this task, which are prompted a small research project. It was recognised that some of these research questions were potentially contentious, nevertheless they aimed to be an initial effort to look at GIS education in New Zealand tertiary institutions, from an Information Systems perspective. This author hoped that the insight gained by such an opening snapshot of then current state of GIS education will provide a useful input for starting up the new unit.

2. BACKGROUND RESEARCH

2.1 IS Curricula and BAppIS

Information Systems is a relatively new discipline. Bugden (1995) states that many IS curricula have been developed recently. In spite of this fact, Sallis (1994) observes "A cursory glance at Information Systems or Information Science (IS) courses around the globe indicates differences in approach and content, although there is a *core of similar topics* present on each." (emphasis added).

An influential early model for these *core topics* of IS curriculum was put forward in the seminal paper by Nunamaker, Couger and Davis (1982, cited in: Des Forges [1995:48]):

"...the nature of the work to be performed by information systems graduates... establishes three major knowledge requirements:

1. information systems technology
2. information systems concepts and processes
3. organisation functions and management (including interpersonal and organisational behaviour)"

The consistency between the above model and the BappIS syllabus is convincing.

The BAppIS has four main topic threads in the programme. These are:

- Information Systems (I units) - Studies the way in which information systems are planned, implemented, utilised and managed within organisations. It also explores the future directions in information systems and the impact of new technologies on the information systems of tomorrow.
- Organisation (O units) - Looks at the procedures and people which make up an organisation. It studies the way organisations can and do operate, the way that people function within the organisation and how they can become more effective.
- Technology (T units) - Is focused on the concepts of technology systems and sub-systems. The emphasis is on the hardware and software requirements of functional systems. Concepts are reinforced with practical experience.
- Software Development (D units) - Focuses on the methods and tools used in software development. Students design, construct and test software, concentrating on good design. The emphasis is on methodologies currently used in industry, however, future directions are considered.

The ideal mix of topics for a IS curriculum can always be debated, but its aim is universally agreed: to actively and pro-actively follow the changing requirements of global and local market place.

2.2 GIS Education

IS curriculum is a lively and an effective research field, the common topics for teaching have emerged. Literature on GIS curriculum research is rather sparse, and there are differing proposals for teaching GIS concepts.

The most detailed guidance and model for GIS teaching is the Core Curriculum from NCGIA, the National Center for Geographic Information and Analysis, in University of California , USA (Goodchild and Kemp, 1989). The material designed for a year long curriculum in GIS, and it is divided into three courses, each of which contains twenty-five units of lecture notes. From an IS perspective, the two database units (Introduction to Spatial Databases, 10 - 12; Databases for GIS, 43 - 44) are the most relevant, however, the contents of these units are dated.

Another paper in the field of GIS curricula research is that by Young (1992). Young proposes a holistic approach to geomatics education and advocates teaching geomatics concepts within integrated geomatics degree programmes. Under the term *geomatics* Young means more than our initial understanding of GIS:

> "Geomatics is a recent term describing an integrated approach to the acquisition and management of spatial data and spatial information. It encompasses traditional discipline area such as the various branches of surveying, cartography, remote sensing and spatial information systems. A geomatics education would reflect the integrated nature of these previously discrete discipline areas in developing a graduate whose professional activities are in producing spatial information for a variety of users" (Young, 1992:289).

The next list shows the four categories of topics combined into the Geomatics concept (Adapted from Young, 1992:291).

Data Acquisition	**Processing**
Field surveying	Computation
Photogrammetry	Adjustment
Derived mapping	Interpretation

Reference data	Analysis (virtual and physical)
Remote sensing	Quality control
GPD	Storage
Other geo-ref.data:	
Hydrographic	
Geographic	
(physical and human)	
Social	
Environmental	

Management	**Dissemination**
Amalgamation	Generic/thematic
Editing	(client specific):
Integrating	Map,plans, diagrams
Modelling	Reports, statistics
Planning	Geographic position data, DEM's
Decision making	Geo-referenced "social" information
Marketing	Electric display
Quality analysis	
Integrity/legal	
Client "contact"	Electronic "maps"
Transfer standards	Setout data
Product communication enhancement	Distribution
Ownership	

A close look at the topics present in the above list reveals the multi-disciplinary nature of Geomatics, and in fact, all core topics of a IS curriculum (see: 2.1 IS Curricula and BAppIS) are detectable, e.g. computation, analysis and modelling. Whereas, traditionally information systems handling spatially-referenced data were seen as special cases of information systems (Maguire, 1991; Cassettari, 1993 etc.), Young (1992) seems to have merged the Information Systems discipline into Geomatics.

In order to produce graduates that meet business needs, i.e. IS professionals that can solve problems of spatial data management, which approach is more appropriate?

Sallis and Benwell (1993) have analysed the skills needed to solve spatial information problems. The authors conclude that "it is highly unlikely that such [required] qualities reside within a single profession" and "we can see that a variety of professionals can contribute to the effective and efficient use of spatial information" (Sallis and Benwell, 1993:206).

Sallis and Benwell visualise the three components of the Geomatics discipline: data, system, and analysis as a triamgle, and place a surveyor at the data apex of the triangle, a computer scientist at the system apex and a user at the analysis apex. The person who is called *mythical expert* by Sallis and Benwell would stand at the centre. The authors stress the point that " it does not seem possible for a single person (i.e. surveyor or computer scientist or user) to individually provide the total solution at the knowledge depth necessary".

The base research also aimed to establish the need for GIS education in a tertiary institution. Fraser and Todd (1993) reported increasing numbers of local authorities using GIS in New Zealand. The proliferation of GIS technology suggest that an adequately educated and trained workforce is, or will be, sought after in the industry. Furthermore, Forer (1995) identifies "market niches, training niches and educational niches" for educational GIS in New Zealand. From an IS perspective the most significant market niches are:

- "The demand by business for staff trained for using the latest technology...
- The demand for staff skilled in applying the technology flexibly within broad application areas...
- The demand for skilled GIS fabricators, people with the ability to model large systems. This is a small but strategically important market based on information science skills" (Forer, 1995:282).

2.3 Research on GIS teaching

The survey was conducted by mailing a questionnaire to New Zealand tertiary institutions with undergraduate courses in Information Systems.

1. If the "GIS" paper is taught in cooperation with other department(s) of the asked institution;
2. If the paper assumes knowledge acquired by the students from paper of other department(s) of the asked institution;
3. Main topics covered by the paper;
4. Influencing factors when designing the paper:

- NCGIA Core Curriculum,
- General academic content of your degree programme,
- Personal research interest [of lecturer teaching the paper],
- Other.

2.4 Responses and Observations

The response rate to this research was high, nearly 100 %. Three universities and one polytechnic offered a total of six GIS subjects from information systems perspective in 1995.

It was observable from the results that GIS concepts from an Information Systems perspective are being mostly taught within the appropriate department of tertiary institutions; cooperation between departments is the exception. Influencing factors when designing the GIS paper do not really differ from the creation process of any other academic subject. There is no uniformly applied model of what to teach.

It was anticipated that there are was a small number of GIS papers offered in New Zealand within IS degree programmes. A reason for this is probably the cost, as Forer (1995:283) states "...almost all GIS teaching is resource intensive of equipment and staff time, both in direct delivery and preparation". Another reasons could be the differing research profile of IS departments and unawareness of recent achievements in this specialised Information Systems field.

2.5 Conclusions

This short research confirmed the author's presumption that GIS topics, introduction to this specific technology, systems development, management of GIS development, and study of social impact of these systems, clearly fit into the general context of a Information Systems curriculum. The total fusion of distinct disciplines into one single degree programme assumes that an average student would fully appreciate the IS related spatial concepts within such an integrated course without having the benefit of knowing the fundamentals of the IS discipline. Present author cannot support this notion. The identified market niches for graduates seemed to validate the merge of a GIS academic subject into an existent IS curriculum.

3. THE TEACHING PHILOSPHY

Choosing the teaching philosophy of the GIS unit was easy. The author has undertaken a diploma course in tertiary teaching offered by the Central Institution of Technology, Wellington. This diploma course promotes accelerated learning techniques (the 'guru' being Eric Jensen, 1998) and generally encourages the creation of *learner-centered* classroom, as opposed to the practice of the traditional and rigid *teacher-centered* teaching method in tertiary teaching environment.

From this author's perspective the most important underlining psychological principle of the learner-centered model is its third premise:

"Learning is a constructive process that occurs best when what is being learned is relevant and meaningful to the learner and when the learner is actively engaged in creating his or her own knowledge and understanding by connecting what is being learned with prior knowledge and experience" (McComb & Whisler, 1997:10).

Another main point is the shift between the teacher and student roles – sharing the ownership and responsibility for learning. According to Vatterott (1995) teachers no longer deliver the curriculum but mediate it in three ways:

1. The teacher designs active learning tasks in which students learn by doing; there are opportunities for choice, autonomy, integration of content from more than one subject, application of content, knowledge, and demonstration of creativity and personal expression in student projects and product.
2. The teacher designs assignments, ideally in partnership with students, as exhibitions or performances those encourage students to produce knowledge, create products, or engage in personal reflections.
3. The teacher directs time and energy from content presentation or paper grading toward the development of activities that focus students on their learning and how they will articulate or demonstrate their learning (Vatterott, 1995).

In a learner-centered classroom environment the students' role become active – they construct their own knowledge in a relatively small class, working on projects that connects to previously learnt and in the same time challenges their minds. These sentiments also well supported by Rose & Nicholl, 1997: Chapter 17, Successful Schooling in Action.

Interesting to note the differing nomenclature used in an IS academic research paper (Bentley, J.F., Lowry, G. R. & Sandy, G. A. 1999:70) where the terms are *"teacher-enabled learning"* and *"student-enabled learning"*. Teacher-enabled learning is characterised by didactic teaching, passive learning, the teacher as the "expert", and where the control of learning rests with the academic. The student-enabled learning places the student into active, self-directed learning, learning by enquiry and ownership of the learning goals.

The multi disciplinary nature of the GIS subject, and the fact that the unit was planned to be offered on

300 level, made this unit a good candidate to implement the above described *learner-centered* or student-enabled learning teaching philosophy.

4. CONTENT OF THE GIS COURSE

The contents of the GIS course offered in 1996, 1997 and 1999, as it is presented in the Bachelor of Applied Information Systems Unit Descriptor.

Title: Spatial Information Systems: Evaluate SIS design solutions in terms of user requirements, D312

Purpose: Learners completing this unit will able to understand basic Spatial Information Systems (SIS)concepts, and how systems development methodologies are applied to SIS. Learners will be able apply basic functions of SIS software, research SIS issues, and analyse SIS requirements

Level: 300

Teaching approaches
When offered: Optional in year 3
Duration: 18 weeks
Student learning hours: 125 (approximately), including
Laboratory hours: 36

Entry information
Prerequisites i250 (Systems Analysis) and D250 (Database Development)

Elements for Pass & Performance criteria

1. Demonstrate an understanding of the basic concepts of SIS:

♦ Spatial Information Systems and SIS are defined correctly
♦ Fundamental concepts of SIS are described correctly

Characteristics of spatial data
Spatial data representation Models: vector, raster, hybrid
Database management systems architectures
Thematic map layers
SIS functions: overlay operations, edge matching, neighbourhood operations, connectivity functions

♦ At least two classification schemes for SIS software functionality are explained logically

2. Analyse system development techniques for SIS:

♦ Mainstream data modelling paradigms are analysed to identify advantages and disadvantages when applied to spatial database design problem.

Data modelling paradigms: entity-relationship models, semantic data models, object-oriented models.

♦ The basics of the Spatially Extended Entity-relationship Model is described correctly. (Firns, 1994)
♦ Common system development cycles are analysed to identify advantages and disadvantages when applied to spatial database design problems

System development cycles: classical approach, reusable code, information engineering/prototyping

♦ a methodology for the creation of spatial information systems explained clearly

3. Research a current issue in SIS

Current issues: Data Acquisition, Remote Sensing and SIS, SIS in Business, SIS and Resource Management Act

♦ SIS literature related to the selected issue is identified correctly
♦ The literature on the selected issue is analysed to identify main themes, trends, areas of disagreement, future direction

4. Apply the basic functions of SIS software.

♦ Basic functions of SIS software are applied to build an application for solving common problems.

Basic Functions: user interface commands, data storage and management, analytical functions.
***Common problems**: optimal routing, site selection etc*

5. Analyse requirements for a SIS.

♦ A clearly defined systems development methodology is applied correctly
♦ User requirements are obtained effectively
♦ Given a statement of user requirements, an SIS is analysed to accurately model the information structure
♦ Supporting documentation is produced of a high standard
♦ A professional approach to all aspects of the systems analysis process is demonstrated

Content/Context:
Topic: Time spent on topic (%)
SIS definitions, basic concepts: 10
Approaches to SIS development: 20
Research on SIS issues: 10
Using SIS software: 30
SIS requirements analysis:30

Assessment procedures
Formative assessment: Lab exercises, Test

Summative assessment
(all must be passed: Research Presentation, Project).

5. THE CLASSROOM EXPERIENCE

5.1 The structure of the unit

The frame within the unit offered is 16 teaching weeks, two hours class weekly. The design of the assessments and the unit programme was led by the notion of avoiding traditional lectures and of provisioning for independent learning. The assessments are described in the previous section of this paper. The structure of the unit:

5 weeks of introduction to basics,

6 weeks of student/myself/industry speaker presentations and the test,

4 weeks for fieldtrips/group assignment/finishing the lab exercises, and

the final class is for a quick review and student evaluation.

The GIS topic is new to the students, they need to come to grips with the basics before they are to succeed in a self-directed learning mode. The way around the problem of not having formal lectures is to use a suitable software package. Idrisi, which is used for educational purposes worldwide was chosen because accompanied with well-written tutorial/exercise books. Through these laboratory exercises the students teach themselves the basic principles and acquire hand-on experience in the same time. The students are also able to look up GISTutor, a software encyclopedia teaching GIS and class discussions follow or proceed these classes. The unit always has invited speakers and great many fieldtrips organised. (eg. 1996 Palmerston North - Landcare Research New Zealand Ltd; 1997 Wellington -IBM & Aoraki Corporation; 1999 Wellington - Spatial Solution, Compudigm, and Critchlow Associates, in Palmerston North - Central Power, and Palmerston North City Council.)

5.1 Statistics

The success rate of this unit always has been high due the students' fascination with this new technology. In 1996 26 students enrolled, 22 students completed the unit, 2 students withdrawn, and only 2 students were not able to meet the requirements. In 1997, from the 10 enrolled students 1 withdrawn and 9 students completed the unit. In 1999 out of 8 enrolled students 7 passed, and one student withdrawn.

5.2 Observations/Student evaluations

Students did not show any difficulty in accepting and appreciating the student-centered teaching method in the year of 1996 - 1997. The student evaluations praised the field trips, industry speakers and the relaxed atmosphere of the classes. Generally the unit measured up to students expectations very well. Most complaint have been made about the old version of the software, and about student colleagues not coming to the presentations or not paying real attention to it. As purchasing new software was out of our reach, only the second problem could be looked at. The general policy of no compulsory attendance of classes does lead sometimes to this type of problem. The pedagogically not sound solution found including a new criterion to the marking schedule of the assignment: "feedback given to presentations". Two missed presentation classes or not acceptable feedback result in failing the assignment. This "solution" worked, and presently it is still in action.

Unexpectedly the most problems were encountered during the third delivery of this unit to the smallest ever class in 1999. For different reasons, the attendance was very poor. Students did not even come to the locally organised fieldtrips, the visit to Wellington meant a shopping opportunity. Another unpleasant incident was that one project group was hardly able to show the initiative necessary to start up the project, achieved a weak solution, yet was asking repetitively for "Distinction" mark. The usual unit evaluation gave unusual complaints about the "lack of teaching-time", lack of laboratory directions and the lack of class exercises. Three members of the class, out of nine, totally misunderstood and rejected the teaching style of this unit, which lead to the conclusion that success in past would not guarantee the same result automatically each time.

6. CONCLUSION

This paper covered a classroom experience from the teacher perspective, from developing a new GIS unit, until the fourth and troubled delivery the unit. Teaching in polytechnics is a great challenge, lecturers not only expected having sound academic qualifications and research capabilities, recent industry experiences, everlasting motivation in continuous self-development, but pioneering, experimenting with and adjusting to new teaching methods and class-room situations together with developing new academic subjects.

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