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Revising IS Curriculum: Positioning Information Systems Specialists for a Web-Based Environment

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REVISING THE CURRICULUM: POSITIONING INFORMATION SYSTEMS SPECIALISTS FOR A WEB-BASED ENVIRONMENT

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Abstract

This paper presents the issues confronting a large Australian university in revising its curriculum in order to effectively respond to the changing demands of the technical environment and an increasing need to produce graduates who are team players. The paper first defines the outcomes of an IS education at this university and then moves on to defining an IS curriculum for 2005 (the target year of the first graduates in the revised program). A brief section on educational approaches then follows, which examines our values and beliefs of education and content inclusion. The paper then examines a range of units that are designed to position the student to become an Information Systems Specialist. The paper closes by reviewing the pressures on universities to keep current content and processes and summarizing the mapping of the final IS curriculum to the objectives in ISCC'99.

Keywords: IS Curriculum, ISCC'99, IS2002

Introduction

There has been much debate on the skills required of Information Systems graduates in the 21st century. Identifying these skills has dominated the curriculum committees agenda over the last decade as evidenced by IS 1999 (Longnecker et al 1999), IS2002 (Gorgone et al 2002) and the Information Systems Centric Curriculum 1999 (Lidtke and Stokes 1999).

In addition to the acquisition of technical skills, industry is asking for graduates to have developed skills in team work, written and oral communication, project management and time management (Underwood 1996, Snoke and Underwood 2001, Snoke and Underwood 2002, Turner and Lowry 1999). Many universities are responding to these requirements through revising their curriculum and through publishing the expected skill set of graduates. These latter skills have been termed graduate capabilities, some of which are 'generic skills' applicable to all disciplines.

This paper presents some of the issues confronting a large Australian university in revising its IS curriculum in order to effectively respond to these changing demands. In this paper, we first define the outcomes of an IS education at this university. We then move onto defining the IS curriculum outcomes for 2005 (the target year of the first graduates in the revised program). A brief section on educational approaches then follows, in which we examine our values and beliefs of education and content inclusion. We then examine a range of units that are designed to position the student to become an Information Systems Specialist. We close by reviewing the pressures on Universities to keep current content and processes and summarizing the mapping of the final IS curriculum to the objectives in ISCC'99.

[1]This paper summarises the results of curriculum development by a number of people within the School of Information Systems. The design team consisted of the senior staff, unit coordinators and sub-discipline heads. This paper represents their outputs and all parties of the team should be recognized, which occurs in the acknowledgement.

Design Issues in Revising the IS program at Queensland University of Technology

A team of senior staff[2] worked in 2000 to refine the IS major in the School of Information Systems, Faculty of Information Technology, Queensland University of Technology. Through a series of workshops, retreats and design sessions, this team challenged their current program and sought to bring it forward to meet the needs of graduates in 2005. Most of our graduates would be working in industry and most would be working in a network-centric and web-enabled organizational setting. In this section, we discuss how the literature on IS curriculum and the expectations of industry of IS graduates informed our curriculum design decisions.

The IS program at QUT is embedded within a Bachelor of Information Technology degree. Students in this degree may specialize in Software Engineering, Computer Science, Network Systems, Information Systems, Electronic Commerce or Emergent Technologies. This degree has a common first year of 8 units (subjects) which all students must complete. These units traditionally included two programming units, one data communication unit, one database application unit, one computer architecture unit, one conceptual modeling unit, one information management unit.[3]

We sought to implement those generic skills identified by Lidkte et al (1999) as shown in Table 1 below.

Table 1. Industry-Defined Attributes of an ISCC '99 Graduate (Lidkte et al 1999)

Personal Skills	Systemic-thinking skills Problem-solving skills Critical-thinking skills Risk-taking skills	Personal-discipline skills Persistence Curiosity
Interpersonal Skills	Collaborative skills Conflict resolution skills	Communication skills (oral, written, listening, and group)
Technical Knowledge and Skills	Information abstraction, representation, and organization Enterprise computing architectures and delivery systems Concepts of information and systems distribution Human behavior and computer interaction	Dynamics of change Process management and systems development Information Systems domain knowledge Use of computing tools to apply knowledge

Gorgone, Davis, Valacich, Topi, Feinstein and Longenecker (2002 : 6-7) echo these elements in their description of the skills expected of IS professionals:

- Broad business and real world perspectives;
- Strong analytical and critical thinking skills;
- Exhibit strong ethical principles and have good interpersonal skills; and
- Design and implement information technology solutions that enhance organizational performance.

Graduate capabilities to be developed in our graduates are:

- Knowledge and skills pertinent to a particular discipline;
- Critical, creative and analytical thinking and effective problem solving;
- Effective communication in a variety of contexts and modes;

[2]These staff are listed in the acknowledgements.

[3]This first year has been radically redesigned and this redesign has been implemented in 2003. This redesign and its consequences are the subject of another paper.

- The capacity for life-long learning;
- The ability to work independently and collaboratively;
- Social and ethical responsibility
- An understanding of indigenous and international perspectives; and
- Characteristics of self-reliance and leadership.

(Queensland University of Technology 2002).

Snoke and Underwood (2001,2002) identified the knowledge, skills and attitudes are expected of graduates in the national context. These qualities are summarized in Figure 1 below.

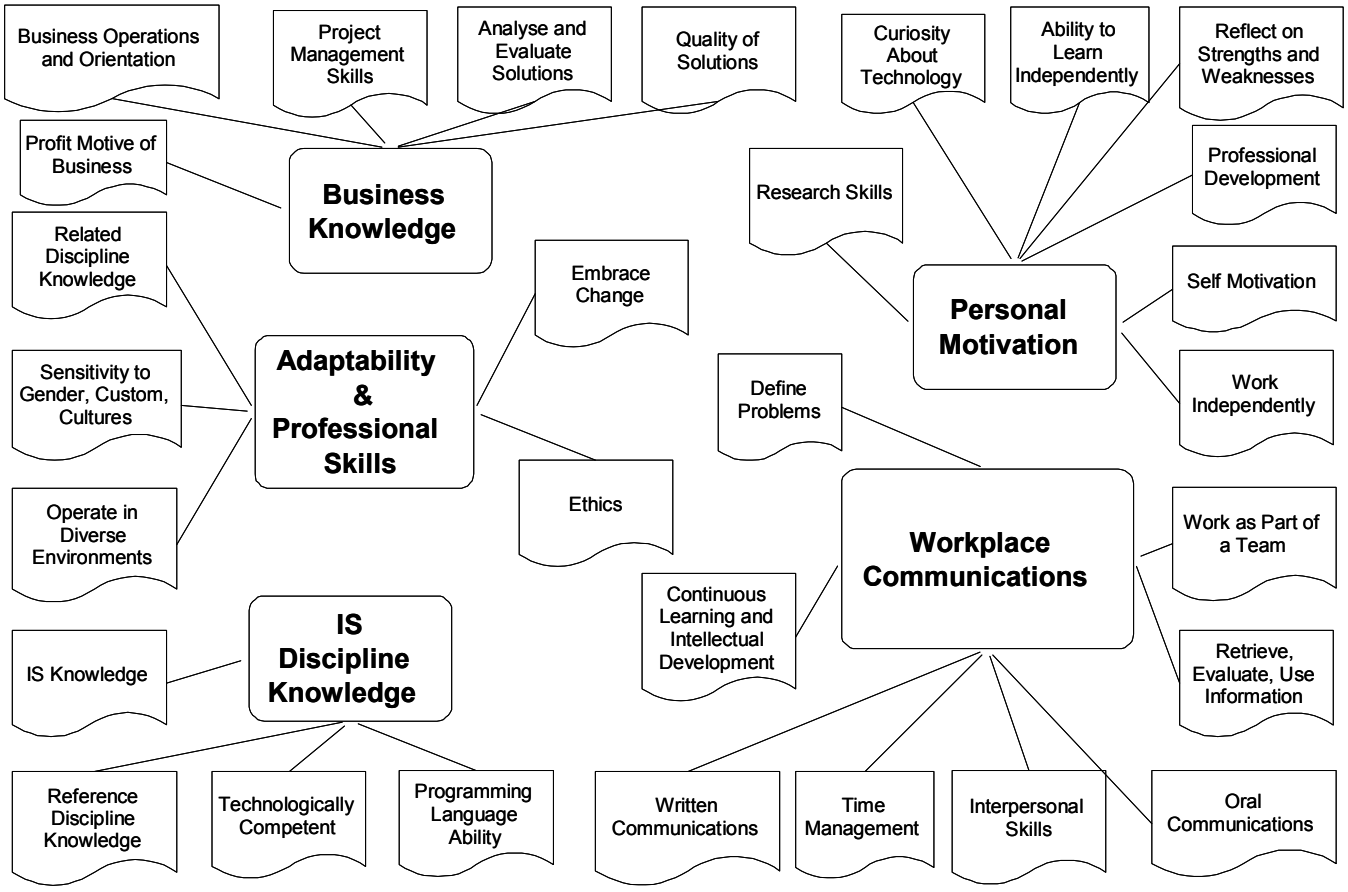

Figure 1. Grouped Generic Skills Set (Snoke and Underwood 2002)

During our curriculum development work, we sought to operationalise these elements. In particular we asked: How could the personal skills component be implemented through the learning experiences in each unit? How could we formally develop the interpersonal skills? Which units are best suited for these experiences and which should remain focused on theoretical knowledge and technical skill acquisition? We then reviewed the technical content and sequencing of our courses in order to identify those elements not supported by our existing curriculum and to determine if and where we needed to incorporate new material.

We assessed the coverage of our degree along these dimensions, and realized that we had been focusing on the acquisition of technical competencies. We realized that, though students were expected to work effectively in groups, we had not adequately prepared the students in workplace communications. On further reflection, we realized that we had a responsibility to develop students in each of the other dimensions as well. This is a specific problem within the Australian context, as degrees are specialist awards. At QUT, in a bachelor's degree, students generally complete 24 units, of which up to 20 units can be solely from the specialization (such as IT, Mathematics, Accounting etc). In the IT degree, there are only four elective units which may taken

from anywhere in the University. This structure means that graduates could not be guaranteed to have developed sufficient business knowledge nor have the expected set of personal and interpersonal skills expected in a generalist degree often offered in North America.

Our Definition of Information Systems Guiding Our Curriculum

We define Information Systems as:

> *The academic field encompassing the activities of developing, acquiring and managing systems supporting organizational and inter-organisational processes.*
>
> In particular, we believe that the discipline of Information Systems involves the creative use of IT for developing systems that achieve business benefits.[4] This requires effective means of data, system and process modeling, the acquisition of programming skills, coupled with skills and knowledge of communication and coordination and decision making. We believe that the systems of the next decade will be web-based, heterogeneous and involve increased use of intelligent agents. Systems will need to be rapidly developed and deployed, as business structures cope with rapid internal and external change. Thus, development times must be short.
>
> Creating systems in these domains requires an understanding of innovation, technology diffusion, quality, HCI, sociotechnical design, and change management. There are methods, techniques, technologies and methodologies supporting each of these activities. An IS graduate will have knowledge and skills in each of these discipline.

After considerable debate, the working party identified that graduates of this program must be able to

- Identify IS problems;
- Communicate concepts;
- Develop alternatives;
- Decompose problems;
- Conceptualise designs;
- Build systems;
- Design systems and tests;
- Validate and deliver support systems;
- Manage all IT processes; and
- Understand the societal implications of their actions.

In conclusion, we saw a need to provide foundational skills that prepare the student for the future, as well as pragmatic skills equipping them to solve problems. The next section discusses our approaches to achieving these outcomes.

Education Approaches to Achieving These Outcomes

We considered the use of Bloom's taxonomy of cognitive skills to frame our curriculum. This involves graduated experiences as follows:

[4] Note that not all staff share this business orientation to curriculum as many are deeply immersed in their specialization and seek to foster the same passionate interest in that specialization in their students. This interest in not necessarily a bad thing.

Table 2. Modified Blooms Taxonomy from Lidtke et al. (1999)

Level	Label	Definition
6	Evaluation	Judge value of material for a specific purpose
5	Synthesis	A creative activity forming new patterns or structures
4	Analysis	Breaking into component parts to understand structure
3	Application	Using learned material in a new situation
2	Comprehension	Able to describe meaning of material
1	Remembering	Recalling learnt material
0	Following Directions	

We sought to analyse the focus of content, learning tasks and assessment at each level. Most of our first year units appear to exercise levels 0,1, and 2. Second year units seem to focus on levels 1,2,3 and third year units seek to develop skills at level 4, with some of our units developing skills at level 5.

These questions lead to the members of the working party articulating and seeking consensus on our shared values and beliefs. These were summarized as belief in the following:

- faculty as coaches not oracles (or distributors of knowledge);
- practical outcomes from most units contributing to a portfolio of skills;
- theory driven courses, developing life long foundational skills, but contributing to pragmatic outcomes for the students;
- an outcomes based education system;
- engagement of the student as an active partner in the learning process;
- orienting the student to a life-long engagement for learning; and
- development of an integrated progression of experiences, building to the desired stated outcome.

These elements led to the design of our IS Major, which is described in the next section.

IS Major Design Process

The IS core must have the start points for the following streams, as most staff and students see their units in terms of technical focus and competency. The set of streams identified as relevant in our school[5] were:

- Database;
- Modeling and conceptualization;
- Programming;
- Creative Web enabled applications supporting E-Business and E-Government;
- Project using project management techniques;
- IT management; and
- Enterprise Systems.

We analysed the fit of existing units to this framework. The modeling and conceptualisation stream consisted of Systems Analysis and Object Modeling and should include more work on process and workflow modeling. The database stream consisted of units on database design, database programming, database management systems, distributed database design and management systems and object oriented database systems. These units needed rationalization and refocusing. The programming stream consists of units teaching Visual Basic, COBOL, and ABAP. The creative web-enabled application stream consisted of units on Human Computer Interface design, Multi-media, Web Enabled E-Commerce site development, and needed updating with new focal areas in web application development , web technologies and web intelligent systems. The IT Management stream consisted of IS

[5]There is a school of Software Engineering and Data Communications within the faculty, and separate Faculty of Business (including schools of management and accounting) and Faculty of Creative Industries (including disciplines in communication and web design) from which students can take electives.

Management, Issues and Values, and Project Management. New material should be developed that addressed key areas in systems planning, benefits realisation, and IT governance. The enterprise systems stream included an Introduction to Enterprise Systems, and exposure to Enterprise Systems Applications as well as R/3 Systems Administration. It could include additional material on Extended Enterprise Systems (including Supply Chain Management, Customer Relationship Management), and Enterprise System Value Management.

IS major students have always completed a project as capstone unit. This unit is taken in small groups and focus on developing a prototype system, preferably for a real client. Students need to develop and exercise a project plan

We asked each curriculum head to extend this list in their specialization and identify those elements that belong in the core common to all IS graduates, and a core common to all IT graduates. Those elements common for all IT graduates would then need to be put into our common first year. We asked the rhetorical questions: What are we missing? What role could the development of a portfolio have for students? How does this approach positively or negatively affect your unit? We then sought to determine how we could best develop the generic skills in IS students, and concluded that the foundation for this work needed to commence in first year (reported elsewhere).

The next section reports on the structure of the revised IS Major.

Structure of IS Major

The IS Major consists of 8 compulsory units and 4 elective units taken from the School of Information Systems. In this section, we briefly describe the composition of the core units.

The major was developed as a set of streams with streams being managed by a subject area group. The streams are technical, database, enterprise systems, conceptual modeling and information management, and subject area groups labeled enterprise systems, database, technical, systems and information management. There is no subject area group responsible for all aspects of modeling, with some being assigned to the database subject area group, others to the systems group and yet others to the enterprise systems subject area group. We will briefly outline the objectives for each of the core units in this section.[6]

There are two core units from the technical stream: Web Applications and Applications Development.

The design of Web Applications seeks to ensure that students can demonstrate knowledge of

- design elements for, and enhancements to, interactive web front ends;
- the software architecture and delivery technologies relevant to web applications;
- database design issues related to developing dynamic, secure web enabled database applications;
- the security implications of web-enabled software.

In this unit, the students should develop practical skills that allow them to

- design a website front end that meets requirements of theory and industry;
- design a simple web application and appropriate relational database;
- develop a web application using Macromedia DreamWeaver UltraDev accessing a Microsoft Access database;
- recall and evaluate significant factual and theoretical content offered in an examination environment.

The Applications Programming unit commences with describing design (*theory*), development (*practices*) and deployment (*application*) of application program. The unit seeks to develop skills related to Rapid Application Development, Coding, Data Connectivity and Data Driven Web Sites for selected Information Systems. In particular, students should be able to:

- structure and design an application for commercial systems;
- use VB.Net programming techniques for the development and deployment of commercial applications;
- use the techniques for embedding a database language, efficient data connectivity in a host language;

[6]These are extracts from the relevant unit outline.

- use VB.Net programming language to maintain a variety of business applications and tools;
- understand Information Technology issues on Data Driven Applications and Data Connections

In this unit, students should have developed practical skills in:

- coding realistic commercial applications using the VB.Net programming environment;
- critically evaluate systems based on good design and Software Engineering principles;
- define a database and manipulate its contents using embedded SQL statements and ActiveX components in a VB.Net application;
- develop simple to complex Data Driven Applications using advanced features of VB.Net programming language and
- critically evaluate Rapid Application Development techniques for commercial applications.

The conceptual modeling stream has two units: Information Systems Specification and Business Systems Analysis, with the first assigned to the database subject area group and the second assigned to the systems subject area group.

In Information Systems Specification, students are introduced to formal specification tools and apply these tools to conceptualise real-world application domains. The students develop knowledge of

- the data and knowledge dimensions present in every problem;
- the static and dynamic elements in every information system;
- the relative applicability of several different modeling techniques; and
- the refinement of a conceptual model to a relational database system.

In addition, students acquire practical skills in

- identifying information elements, types, roles, and relationships;
- applying different techniques to construct static models (ORM for reference) and
- applying different techniques to construct dynamic and process models (Z for reference).

In Business Systems Analysis, students are introduced to the tools, techniques and methods used in the analysis and design of information systems. Secondly, it seeks to develop the student's skills in assessing and critically thinking about the issues, rather than simply repeating learned information. In addition, students will develop practical skills in carrying out analysis, using specified techniques, for a real-life information system and document the requirements in a suitable format.

In particular, students are introduced to

- the work of a Systems Analyst and the nature of a systems development project;
- the value of a sound methodology for Systems Analysis and Design;
- the major techniques practiced by Systems Analysts and
- project planning and control.

Each other stream has one unit in the core of the IS major.

For the database stream, students complete the unit Database Systems, in which students develop an understanding of the fundamental knowledge required to monitor a database management system (DBMS). It does so through providing a detailed introduction to the functions of a database management system. This unit seeks to develop skills for data management not only on an operational level, but also for planning and decision support through data warehousing and data mining techniques. This unit also introduces concepts for some of the common features that are needed by advanced applications such as active database, spatial database and multimedia database applications.

In the enterprise systems stream, students complete the unit Enterprise Systems in which, students are presented with and discuss the Enterprise Systems Lifecycle model addressing the total cost of ownership, change management requirements and process modeling requirements in order to achieve business benefits. This unit introduces the technical architecture of complex 3-tiered client server environments. It seeks to show how an integrated complex database environment meets business needs. A series of practical workshops are used to develop a deeper understanding of the basic processes in business, with a focus on the procurement cycle and the sales to order fulfillment cycle. Students also gain practical skills in using the SAP R/3 Application

system, but focuses on developing a deeper understanding of the integration of these processes using a process modeling perspective. This unit explicitly seeks to develop critical thinking, problem solving, and report writing skills.

The unit is called Communication Skills for the IT specialist seeks to develop the written and oral communication skills of IT students and is taught by faculty from the Faculty of Creative Industries.[7]

Finally, students are required to undertake a capstone industry based project in the unit IS Project. In this unit, students:

- prepare a Project Proposal, including the planning of tasks and an appropriate time schedule for a substantial information systems project;
- determine user requirements in relation to the product or system that is developed;
- develop a product or system for a defined use;
- prepare appropriate documentation of the product, or in support of a developed system and
- demonstrate a capability of critical, reflective and creative thinking and evaluation.

Each stream has a coherent set of extension units so that students can specialize if the desire. The major rules requires the student to complete 4 units in the IS major elective list. Additional specializations are also possible such as Systems Consulting with the units IT Project Management, IT Management Issues and IT Consulting; Multi-media: with Multimedia, Advanced Multimedia, and Interactivity Design; or Enterprise Systems with Applications, ABAP and R/3 Systems Administration.

Mapping the Course Into the Objectives of ISCC'99

The objectives of the ISCC'99 proposed a range of competencies in personal skills, interpersonal skills and technical competencies. In this section, the mappings for these elements are briefly discussed.

The technical competencies include information abstraction, representation, and organization. Skills in this area are acquired in Information Systems Specification and Business Systems Analysis. Enterprise computing architectures and delivery systems are introduced in the unit Enterprise Systems. Concepts of information and systems distribution are introduced in first year and extended in the unit Enterprise Systems. Human behavior and computer interaction are focal elements in the units on Web Application development, but are mainly extended in the elective stream on interactivity design. Issues in the dynamics of change are introduced in the unit on Enterprise Systems. Process management and systems development are introduced in the units Enterprise Systems and Business Systems Analysis. Information Systems domain knowledge is found in each of the core IS major units. Use of computing tools to apply knowledge is not a focus of this major, though appropriate tools for analyzing and modeling systems are introduced in units such as Enterprise Systems and Business Systems and Analysis.

Not all of the personal skills components are explicitly taught but are assumed competencies. These skills include systemic-thinking skills, problem-solving skills, critical-thinking skills, risk-taking skills, personal-discipline skills, persistence, and curiosity. Developing competencies in these areas became a focal point for the redesign of the first year course, as the assessment items in many units expect strong personal and interpersonal skills. Systemic thinking and problem solving skills are explicitly taught in the modeling units Business Systems Analysis and Information Systems Specification. Critical thinking is experienced in the more discursive assignments found in the unit Enterprise Systems, where students have to assess the degree of fit of an Enterprise System to the IS portfolio of an organization.

Finally, the interpersonal skills components of collaborative skills, conflict resolution skills and communication skills (oral, written, listening and group) are developed through the setting of group assignments in many of the units in the IS major, but are not taught. Communication skills, as stated before, were formally taught in the unit on professional communication. Our work in the development of the IS major made us realize that we did not formally teach the other expected skills in collaboration, effective group work and conflict resolution. The development of these skills were moved into the new first year units of Professional Studies 1 and Professional Studies 2, which is briefly discussed in the next section.

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[7]This latter unit has been discontinued from 2004, and is replaced by two units within the new first year curriculum called Professional Studies. This set of units introduces the students to team work, professional communication and creative thinking through developing a web-enabled application for a case study business.

The development of this first year is reported elsewhere, but the key element for this paper is to highlight the design intent for the units on Professional Studies in order to develop the interpersonal and personal skills components. The first Professional Studies unit introduces the student to working in teams, with formal material on team dynamics, project management, conflict resolution and negotiation. This material is delivered as lectures and in workshops. In addition, the unit introduces students to effective professional communication. The students develop design documentation, analysing user requirements and validating their design. From the technical viewpoint, the unit introduces the student to the role of information systems in organisations and discusses the technological, social and professional aspects of business systems. We believe that Information Technology students are motivated by a desire to build products. To ground this unit in a product build, students work in a team to build a web site for a target organisation described in a case study. The web site purpose is to be an information portal. The students' final presentation is a demonstration of their product, seeking to 'win the contract' to enhance their prototype web site. In addition, the unit provides students with an opportunity to better understand their personal learning, decision making and information gathering styles, thereby increasing their personal competencies and understanding of others.

These skills are developed further in Professional Studies 2 in which the students extend the information portal developed in Professional Studies and make it dynamic, through the inclusion of reports, data input facilities and supporting ad hoc queries. Further work on communication focusing on user documentation, persuasive speaking and creative thinking are covered. Students again work in teams and develop more reflective and sensitive strategies in working in teams. The notions of high performing teams are introduced and developed through a series of exercises and role plays.

The implications for the IS major from these two units is that students will be formally taught and assessed on their skills in the personal and interpersonal skills domains, and that these skills can be refined through group work, reporting writing and presentations in subsequent units. Some material taught in the Web Applications unit will be moved into first year, allowing for more advanced material to be introduced into that unit. No other core IS major units have been affected in terms of the technical or theoretical content, other than the discontinuation of the Communications unit.

Success of the IS Major

The IS major attracts about 200 students each semester. Success of the unit designs are seen is very large number of students taking core IS units as part of their elective stream. Table 3 summarises the enrolments in these units over the three semesters of offering:

Table 3. Distribution of Unit Selection Since IS Major Was Restructured

Unit	Semester 1 2002	Semester 2 2002	Semester 1 2003
ITB227 Web Applications	325	269	411
ITB218 Applications Programming	157 (as 219 with VB)	197 (as 219 with VB)	260 (with .NET)
ITB220 Business Systems Analysis	128	161	172
ITB232 Database Systems	201	126	253
ITB228 Enterprise Systems	181	197	277
KWB010 Communications for the IT Specialist	143	119	265
ITB229 Information Systems Specification	139	203	225
ITB240 IS Project	54	79	74

These figures show a slight increase in the enrolment into the major. Of more interest, is the fact that some of the units are attracting a number of students from other majors. Of particular interest is the popularity of the Web Applications and Applications Programming units, with very strong enrolment in the unit on Enterprise Systems from non-IS majors.

The unit ITB220 is undergoing further revision, with more on process modeling being introduced. As mentioned previously, content from Web Applications is now being moved into the first year unit Professional Studies 2. Applications Programming is being revised again, with more .NET material being included. The unit on Database Systems is being revised to include more material on database management. The unit on Communications for the IT Specialist is being replaced by a unit on IT

Management, though discussions are underway to replace it with IT Project Management, with this latter unit facilitating the development of the project plan to be implemented in the compulsory IS Project.

Conclusion

We sought to develop a coherent IS curriculum that meets the needs of students joining the work-force in 2005. We used the framing curriculum documents ISCC 99 and IS2000 to assist in our formulation. In addition, we recognized that foundation soft-skills were required, and acknowledged that that new environments and requirements will impose themselves on us and the students. We sought to ground our curriculum in such a way to support skills in that area uniquely defining IS – the ability to conceptualise and develop new systems for tomorrow's problems coupled with the ability to communicate those solutions effectively.

The new major has effectively equipped the student with the skills required to develop application systems in the web-centric world. The large enrolment in the Web Applications and increase in the .NET units validates our belief that many students link information technology with the web. Through this medium, we seek to develop strong competencies in each of the required elements expected of an IS professional.

The restructure of the IS major has been a success for the School as evidenced by student satisfaction surveys, uptake of the core units as electives by other students and increased enrolment in the IS major. These successes and the needs to refine the degree to cater for changing work environment subsequently lead the Faculty to revise its first year. The impact of this revision is reported elsewhere, but the key change to the Information Systems major structure was the movement of the communication unit into first year, as part of a Professional Studies unit. We recognized that we were not adequately addressing the expected skills demanded by industry as evidenced in the ISCC'99 documentation and the IS2002 curriculum. We have subsequently revised our compulsory first year units in order to meet these requirements. Through these foundational studies, and extended through the units in the IS Major, we anticipate preparing better graduates for industry, as well as students capable of and interested in research.

This curriculum is under constant review as the discipline changes and both student and industry expectations shift. In addition, recent high school graduates have greater technical competencies in the IT domain and thus, the challenges of the units must shift to maintain student interest. Finally, we note that though industry is demanding greater interpersonal and personal skills for employees, it is very difficult to excite technically oriented students to develop skills in these domains. This aspect requires further research and development. The mapping of the revised IS Major, together with its first year elements, to the IS2002 curriculum is currently underway. Student satisfaction with the course is being evaluated, but industry satisfaction with its output will not commence until 2006 – one year after the first graduates from this new structure reach the workforce.

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