Analysing teaching design repositories

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We describe a software application that supports teaching, research and administration by integrating a teaching design repository with a statistical reporting tool. In this paper we describe a quantitative approach that supports institutional collaboration and the assurance and improvement of quality teaching. The tool analyses key features in unit of study outlines and synthesises the information. Most data are collected from internal administrative processes within the faculty. The prototype system is designed to present various kinds of information from the different points of view of students, academic staff and academic managers who have access to information produced by the reporting tool.

Keywords: quality teaching, reporting tool, statistical analysis

Introduction

Improving the quality of teaching practices within an organization is a difficult task. Several authors have discussed different approaches to quality assurance, their philosophical underpinning and their benefits (Barrie, 2003; Biggs, 2001; Ramsden, 2003). In this paper we discuss a software application built as part of a quantitative approach to supporting quality teaching. The application has a focus on helping teachers in the process of designing and managing units of study and in modelling the institutional approaches to teaching design, instead of institutional approaches to administrative tasks. Until recently, the statistical analysis of how units of study are taught in an academic unit was hard, mostly because this data was not easily available, so only individual research studies could be performed. In a recent project at the Faculty of Engineering, University of Sydney a Unit of Study database was built (Calvo et al., 2005) and all the teaching design information is managed there. Once the information is stored in a database, it can be made available in new ways to support quality educational design. Academics can compare their designs over time or with other strategies; Teaching and Learning committees and educational researchers can review design trends or identify designs that are particularly successful; staff can communicate curricula information to students in more effective and innovative ways (e.g. via visual or interactive representations of units or degree pathways.)

Teaching has always been one of the major functions of universities in Australia and, together with research, teaching is the lifeblood of university life for both academic staff and students (Lally & Myhill, 1994). The importance of good teaching, both in its own right and as a basis for encouraging independent learning beyond the defined curriculum, has been recognised for many yeas as one of the fundamental aims of higher education (Linke Report, 1991). Currently, educational researchers propose different approaches to ensure the quality for teaching and learning. According to Biggs (2001) there are three stages in the reflective practice of an institution: a quality model, quality enhancement and quality feasibility. These three are the essential ingredients in the prospective quality assurance model we use here.

Other researchers have developed ideas to embody the student-focussed learning perspective and look into university policy (Barrie & Prosser, 2003) and its implications to further enhance the quality of teaching and learning. A method by which a university can a combine students' survey data with information from other sources to enhance the quality assurance is described by Ramsden (2003). A web-based mapping tool (Lowe & Marshall, 2004) is shown to inform staff development strategies to facilitate reflection and renewal of curriculum for both individual units and courses of study. Most traditional research and review into the quality teaching concentrate on the student questionnaire of teaching, there are however others resources we need to take into account carefully. We describe a quantitative approach to provide the curriculum information for enrolled students and academic staff and the strategic support for the decision-maker based on the collected data. Laurillard (2002) describes a related model for institutional infrastructure that supports her conversational model at the institutional level.

The purpose of this paper is to describe a reporting and statistical analysis tool designed to improve teaching design, and use our faculty as a case study. The tool uses unit of study outlines and other information collected from academics for compliance with the university and faculty teaching and learning policy. The reports present a summary of key features in educational design. By looking at the extended academic unit and its organization infrastructure we aim for the tool to also show the linkage among different activities (research, teaching and administration) in which staff are normally involved and the way to manage these effectively. These activities are not improved by the tool itself, but by the processes it supports.

The remainder of this paper is organized as follows. In the next section, we address the institutional context and factors determining the quality teaching 'measures'. Then we describe the application and some of its technical implementation details. Next, our Faculty experience is used as a case study on the basis of analysing the key features of quality teaching and some of the interesting results derived from the interim data collected. Finally, some concluding remarks are given in the last section.

Institutional context and factors

The institutional background

Universities are considered 'learning organizations' when they conduct an internal learning conversation that allows them to learn from experience and adapt to the environment (Laurillard, 2002). From the institutional perspective, the learning organization is expected to make its parts coherent and coincident and run efficiently and effectively. Teaching quality is not separable from the department or discipline area, infrastructural and administrative context in which it is embedded (Lally & Myhill, 1994). The gap between teaching and research has been reduced in universities that encourage their academic staff to engage in both teaching and research activities. By doing this institutions expect that academics will keep the units of study they teach updated with current research, that more practical results will be taught to stimulate the students' motivation and that the close synergy between research and teaching will ensure that a university remains a true centre of learning (Laurillard, 2002). Following this integrative approach we have designed statistical reports of three types of measures: teaching, research and administration, with a focus on the first area.

Additionally, academic management is also a key to influence teaching. Management must look into staff development programmes, teaching workload, reporting within and outside the university, and resource allocation for new staff and new infrastructure. The staff development programmes help raise academics' awareness of current teaching practices, new teaching technologies.

Key measures of quality teaching

Generally speaking, there are no quantitative instruments that can be applied to all universities. Each one has a different context, a multiplicity of quality attributes defined within each department, and each academic unit or university will use different measures of quality based on their particular institutional background. We have identified five essential features on the basis of the quality teaching dimensions (Lally & Myhill, 1994) for which we collect information: teaching methods, learning approaches, assessment methods, graduate attributes, and curriculum design (Table 1 and Table 2).

Good teachers are expected to use a variety of appropriate teaching methods that help students develop 'graduate attributes', such as critical thinking skills and judging the evidence to make conclusions. There is great difference between disciplines with respect to the distribution of teaching methods used to develop these and other graduate attributes. In some disciplines teachers prefer lectures, in others they might prefer laboratory work, using computers and electrical equipment as an instrument used in the departments emphasising the development of practical skills. Most teachers are inclined to apply several teaching methods rather than a single method. They also adapt the teaching methods to the group of students. First year students are more likely to benefit from methods that provide additional scaffolding, and the senior students from more independent study.

Other teaching design decisions, such as assessment methods, are key points to understanding the process of students' learning, since they are the drivers to how students go about their learning activities.

Teachers must decide on assessment methods and the weighting they give to each. Both variables are important and can be used in a statistical analysis of institutional approaches to student assessment. This analysis can then be used to evaluate the impact of new policies, trends, staff development programs, etc.

Table 1: List of key features and examples for quality teaching

Key features	Examples for key features	
Teaching methods	Lectures	Laboratory work
	Tutorials	Project
Learning approaches	Independent study	Exercises
	Discussions	Field trips
	E-learning	Consultation
Assessment methods	Quizzes	Laboratory performance
	Final exam	Participation and attendance
	Presentation	Assignment submission
Graduate attributes	Information literacy	Personal and intellectual autonomy
	Research and inquiry	Communication
	Ethical, social and professional understanding	
Curriculum design	Curriculum content	Curriculum workload
	Weekly assessment	

Table 2: List of main analysis approaches for quality teaching

Key features	Analysis approaches	
Teaching methods	Popular teaching method	Joint teaching methods
	Department-wide teaching method	Annual teaching method
Learning approaches	Popular learning approach	Joint learning methods
	Department-wide learning method	Annual learning method
Assessment methods	Popular assessment method	Joint assessment methods
	Department-wide assessment method	Assessment method weighting
Graduate attributes	Popular graduate attributes	Joint graduate attributes
	Department-wide graduate attributes	Graduate attributes level
	Average graduate attributes	
Curriculum design	Weekly curriculum schedule	Curriculum load level
	Student workload	Frequency of unit of study revisions
Linkage of features	Linkage of teaching and learning	Linkage of teaching and assessment
	Linkage of teaching and graduate attributes	Linkage of assessment and graduate attributes

The analysis may have many other applications. It has become increasingly important to identify the graduate attributes developed in each unit and course of study. Detailed descriptions are required by accreditation institutions and by academic management. These skills are considered important for students to make the successful transition from the university to the workplace. For the units of study focusing on developing critical thinking and problem solving skills, a high level of research and inquiry focus is required to reach the aim. On the other hand, the attribute of communication is much needed in dealing with the unit of study whose objective is to communicate clearly and effectively. The statistical analysis (e.g., average) for the graduate attribute in department-wide or stream-wide constitutes a fundamental evidence to gain insight on the generic skills developed.

The curriculum design is another dimension we take into account to investigate if the curriculum planning fits well with other units of study and the level and difficulty of workload is appropriate. Our application design also provides statistical analysis of workload data because this is a common area of concern amongst engineering students and academics. A fully articulated syllabus with a balanced workload produces useful information leading to better learning for students.

The relationship among the key features mentioned above is another factor to observe. They must be linked together to support quality teaching. One example of interaction is the choice of teaching methods

and its alignment with the learning approaches and assessment methods. To some extend the teaching objectives and method, and the corresponding assessment determine the way students learn.

Key features describing research and administration

The second and third areas that our tool aims at are research and administration, as they are believed to influence quality teaching. Research projects and their funding are critical parts to describe research activities in an academic unit. The number and the size of grants and scholarships received are often used as a simplified measure of the research team achievement and contribution. In addition, the quality and quantity of publications also determine the research achievements (Table 3).

The management of human resources consists of the staff components, the ratio of staff and students, staff workload and their professional development strategy. The academic, general staff and managers playing different roles are working in a coordinated way to ensure quality teaching and the efficient organization. Our faculty has carried out a variety of activities to enhance the staff development such as training activities and seminars (Table 3).

The reports can also help with resource allocation. The unit of study database provides us with the overall picture of a range of courses offered by the entire department and/or faculty. The proper distribution of the units load including the core, recommended and elective for every year and semester will affect the academic staff and students' workload. The sharing of the units is found across the departments and streams and resources reallocation will possibly occur with respect to the students, staff and facilities. The other administrative issues emphasising on the learning resources management and the curriculum revisions are required to be recognized. The updated curriculum design can reflect the current knowledge structure and encourage the students to engage in the unit of study learning (Table 3).

Table 3: List of main analysis approaches for research and administration

Key aspects	Analysis approaches	
Research	Research project	Research population
	Funding and grants	Contribution
	Publication	
Administration	Unit of Study (UoS) load	UoS status
	New UoS planning	Shared UoS
	Textbook list	UoS data collection
Human resource	Staff member component	Staff workload
	Staff–student ratio	Staff position
	Staff development strategy	

Application and software implementation

Our application is implemented using the OpenACS web application framework (Calvo & Peterson, 2002) using AOLServer, Tcl programming language and PostgreSQL database. It is based on Curriculum Central (Calvo et al., 2005), a system for managing Units of Study outlines, and is made available to other institutions as open source. The reporting tool discussed here produces diverse kinds of analysis reports including teaching, research and administration. It can be divided into three modules according to the provided functionality: the first level of function is presented for the current students to access the faculty-wide units of study in visual and graphical style. Students can view a specific course structure, understand the relationships between the different courses, learn about the graduate attributes developed and detailed information in each unit of study. The second level helps the academic staff to create, design and review all the processes of teaching to make sure it provides a suitable environment for the students to learn and in the meantime it allows a space for staff to supply the data related to the research and administration. The information includes syllabus, teaching methods, assessment methods, graduate attributes, teaching and learning research projects, funding and staff development. All the summarized and strategic information with quality teaching centred is indicated in the third level based on the reporting tool. The internal data obtained from the staff and the potential external resources constitutes a large repository. After they are transferred into the relational database by manual loading or automatic

information extraction, three-layer functionalities are developed and implemented to inform different groups: students, academic staff and decision-maker in a number of ways (Figure 1).

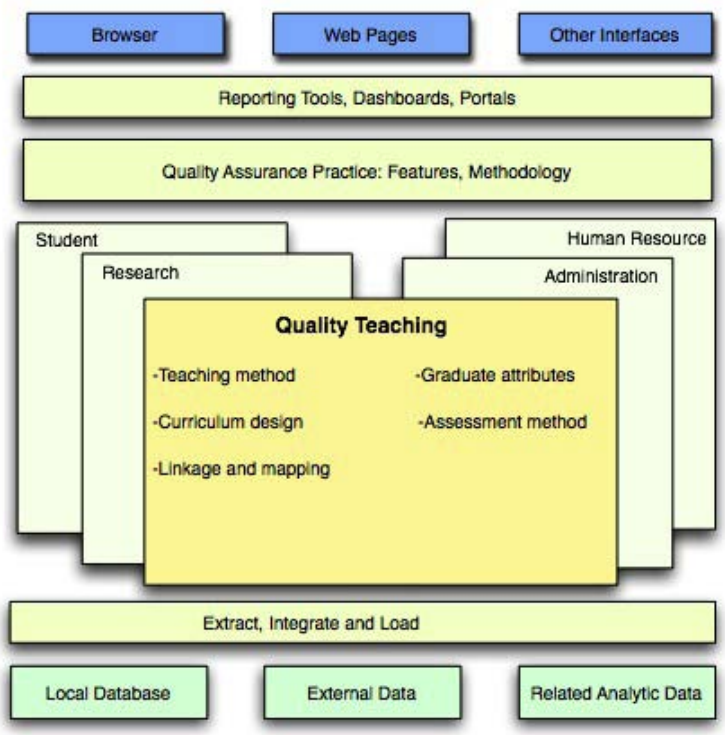

Figure 1: Application framework

Case study: Faculty of Engineering at the University of Sydney

Curriculum development workflow

The University of Sydney is a large, research-focused and multi-disciplinary university. In the past few years, the administration that specifies policies conditioning teaching and learning activities has proposed new policies and procedures for quality assurance. They include a performance-based funding model for teaching and learning, faculty teaching and learning plans and Academic Board reviews of faculties' teaching, learning and research training (Barrie & Prosser, 2003).

The Faculty of Engineering has four schools: Aerospace, Mechanical and Mechatronic Engineering (AMME), Civil Engineering (CE), Chemical and Biomolecular Engineering (CBE) and Electrical and Information Engineering (EIE). Each school provides several streams or courses leading to specialisations in a specific engineering field. There are approximately 300 units of study taught by the faculty including core, recommended and elective units. The unit of study design and quality assurance follows the workflow shown in Figure 2. First, the stream coordinator inputs the unit of study administrative information, including the unit coordinator, sessions, prerequisite, assumed knowledge and so on. Second, the unit coordinator is reviews the unit of study outline and supplies detailed information for teaching and learning arrangements, graduate attributes, assessment and curriculum design. Third, when the outline is finished, it is submitted to the stream coordinator. The stream examines it and provides suggestions or comments and, if satisfied, approves and publishes it, otherwise may request changes to the coordinator. The specific unit of study will only be visible to the students when closed and approved by the stream coordinator. The aim of this workflow is to guarantee the good quality of the descriptions, and to provide a central repository from which others can obtain information about the curricula. On the top of Figure 2 we show how the information can be used by the academic managers (decision-makers) to gain insight of the current teaching and learning practices. The system allows for institutions to adapt this workflow to their needs.

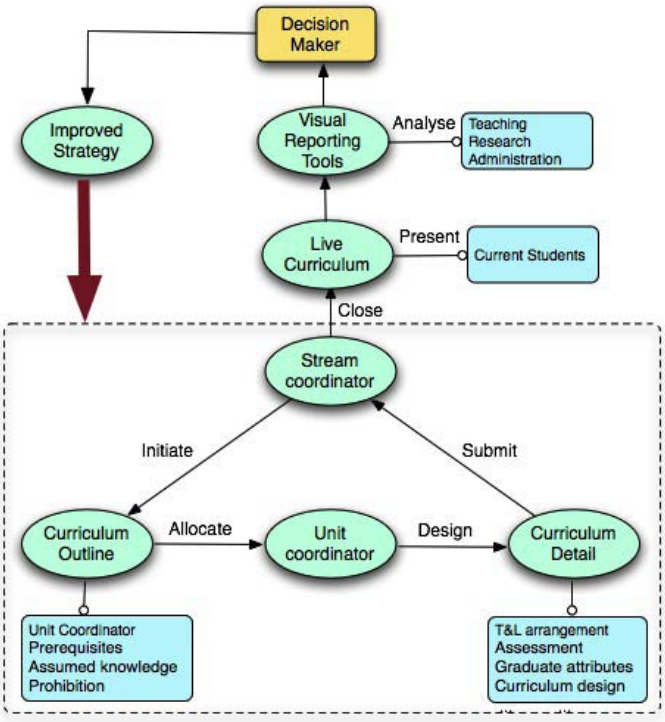

Figure 2: Curriculum inspection workflow

From the students' view, they can explore the graphical representations that display information about the specific course structure, the detailed syllabus of a particular unit of study including credit points allocated, objective, assumed knowledge, assessment methods and so on. This information is available through all the semester as the reference of the learning process and encourages students to be engaged in the learning experience. Figure 3 shows a screenshot of the unit map that gives students a picture of the course structure by listing all the units of study according to the different year and semester. Figure 4 shows a unit of study outline as seen by students.

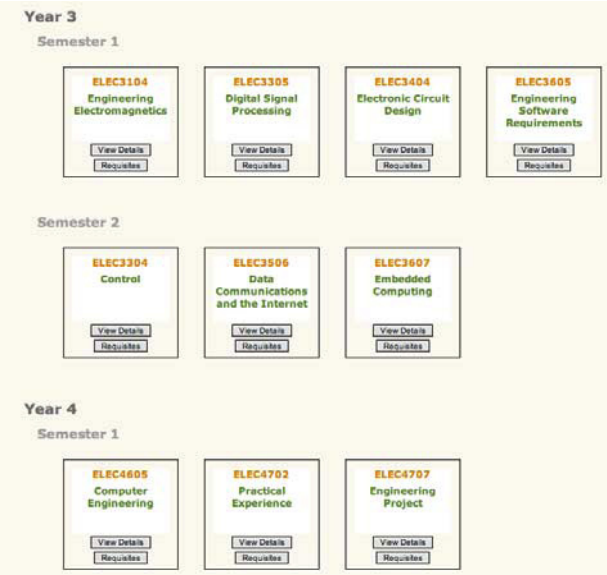

Figure 3: Course structure

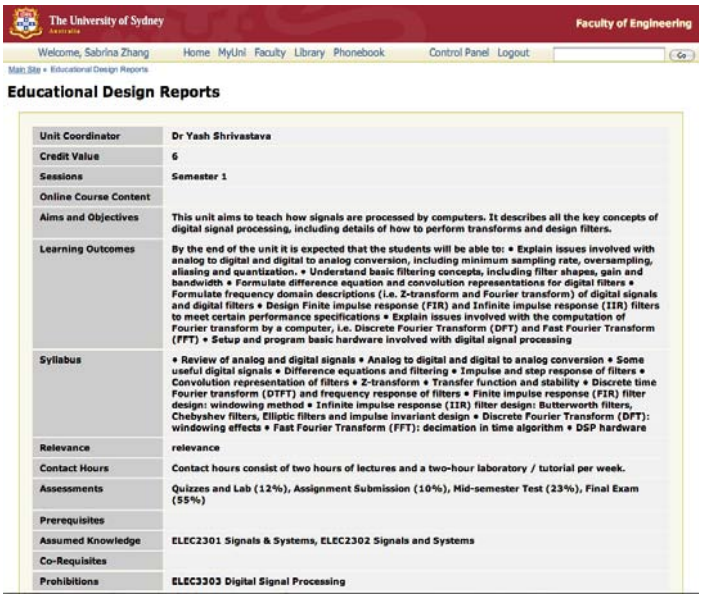

Figure 4: UoS outline

Results

Not all unit coordinators filled all the information required despite being required by the administration. Academics expressed multiple reasons, from the lack of time to lack of understanding on how to do it. We produced two sets of statistical values: 'net percentages' that do not count units that did not respond to the particular item, and 'gross percentages' that count all units in the academic unit.

In the data collected for our faculty, we found that lectures (used in 79.1% of all the units and 95.3% of the units with data), tutorials (62.1% and 74.8%) and labs (35.4% and 42.6%) are the most popular teaching methods within the faculty (Figure 5). The different percentage for the same teaching method indicates the extent to which the relative information is stored in the system. The column 'difference with average' highlights outliers by showing the difference with the faculty average. In terms of the learning approaches, independent study (15.5%) is the most mentioned by academics, followed by projects (10.1%) and e-learning (6.3%). Most academics prefer to apply two or three teaching methods together rather than one which result in the diversity of the learning approaches and student experience.

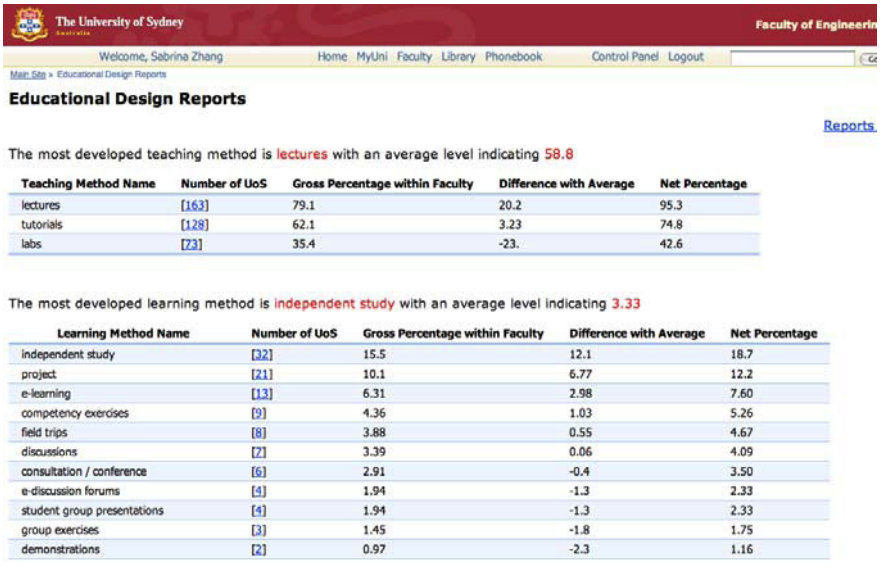

Figure 5: Teaching and learning methods analysis

With respect to the assessment, Figure 6 shows that final examinations account for the largest percentage (61.6% and 71.7%) followed by the assignment submission (46.1% and 53.6%) and projects (28.6% and 33.3%). Although educational researchers agree that novel assessment methods should be used besides the final examination, the examination is still the most weighted method. This analysis can be used to learn about assessment strategies that are being used and maybe support academics who take innovative approaches. The combination of various methods leading to the proper evaluation will be an important aspect in coping with the curriculum development. We also provide an analysis in the individual department and the results indicate that different methods deployment occurs in the different school.

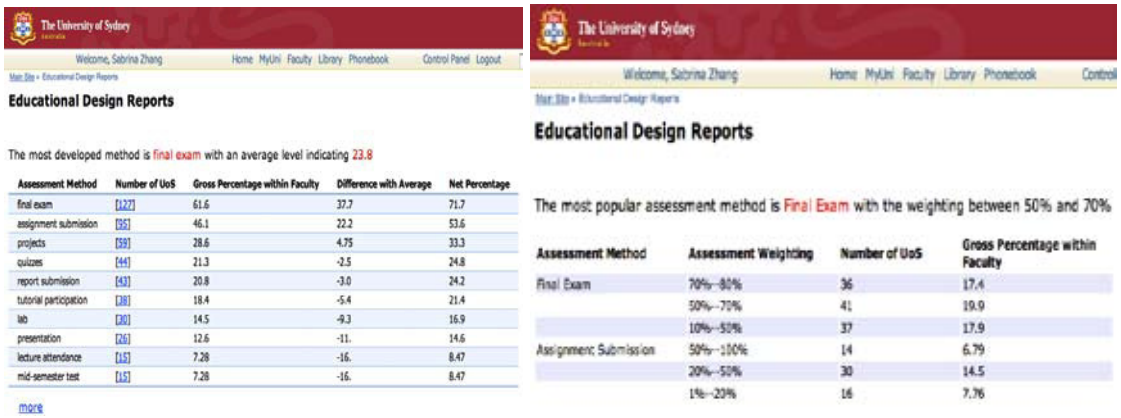

Figure 6: Assessment methods analysis

The analysis of the development of graduate attributes showed that they have been widely considered in the design of the curriculum and more than half of the entire units of study intend to develop over three kinds of graduate attributes (Figure 7). Among the five graduate attributes officially designed for our faculty, the attribute of 'research and inquiry' is the most popular one, followed by 'personal and intellectual autonomy', 'information and literacy', 'communication' and finally 'ethical and social professional understanding'. Students are predicted to develop various skills and meet the industry requirements after graduation so more and more academics tend to pay attention to the graduate attribute development which can be shown from the evidence of the reports. Academics assign levels in the 1 to 5 range, according to how much emphasis to place on each attribute. Communication skills have the lowest level in more than thirty percent of the units of study, and only a small number of units of study are designed to develop the high-level communication skills. The analysis of the graduate attributes provides evidence that might help in the improvement of the curriculum design.

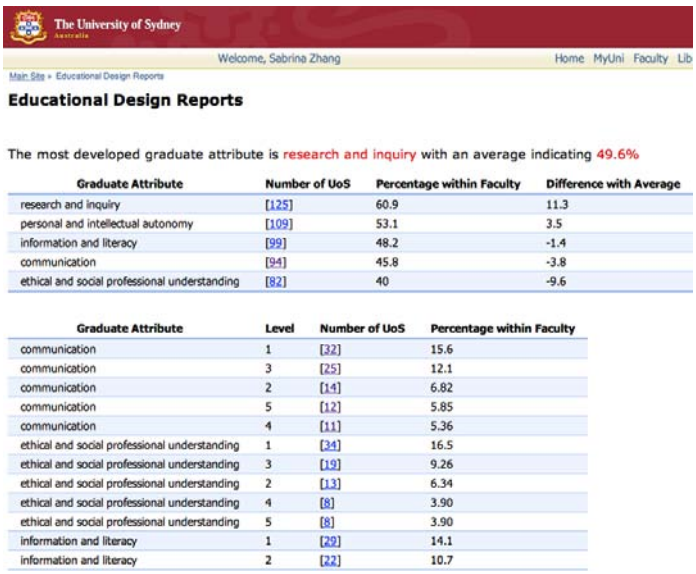

Figure 7: Graduate attributes analysis

Regarding the curriculum content, the weekly schedule informs us the workload allocation and assessment in each week during the semester. The appropriate workload allocation in each week contributes much to enhance students understanding of the new knowledge and otherwise the overloaded or insufficient homework will have a negative influence on students learning process. In addition, the comprehensive analysis of all enrolled units of study for the individual student is explored to makes us aware of the student's workload and propose more reasonable guidance for the enrolment of the offered units of study.

The statistical reports provided can also be used to compare common educational design approaches between institutions. In a separate project we are producing a collection of educational design descriptions from Open Courseware initiatives such as the one at the Massachusetts Institute of Technology. The courses in these repositories contain a syllabus that tells us a lot about how the courses are taught. With the tool described here we will be able to statistically compare educational design approaches between institutions.

Conclusion

We have described a quantitative approach to supporting quality teaching practices based on a software application that collects and analyses educational design data. We have used the Faculty of Engineering at the University of Sydney as a case study of how the tool can be used. The key features of quality teaching we have used where the teaching methods, assessment, curriculum design and graduate attributes defined are considered as the backbone of the practical analysis in the engineering faculty. The research and administration activities closely associated with teaching are involved to constitute the big picture of the learning organizational infrastructure.

The tool was developed to provide statistical information for the decision-makers, academic staff and current students. The generated concept maps and visualisation tools help students have deep understanding of the course structure, syllabus and connections. The strict workflow for the development of the curriculum supports quality assurance of teaching and learning approaches within the faculty and provides an opportunity for academics to learn from each other's experiences, and to raise the practice of quality teaching. The results from a series of reports are proved to be the evidence of the improvement of the teaching and also figure out the key points the decision-makers need rethinking and developing further in the future.

We have not described the quality improvement process in which the data produced by this tool is used by the teachers to change individual syllabus, or the process used by academic managers to change degree structures or to take other administrative decisions. We have only mentioned that this is done by the learning and teaching and undergraduate committees. This is partially because the tools described here are still new and they still have to be integrated into the continued UoS improvement processes.
The tools give management information but the educational context in which they are used is much complex. In our faculty that context is one of continuous improvement primarily through promoting innovation and through the development of systems that embed innovative and improved practices, making them a sustainable norm.

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