An Overview of Computing Science Curriculum Developments at the University of the South Pacific

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Introduction

The economic competitiveness of nations depends increasingly on the effective utilisation of modern technology. As a result, computers and the field of computing science are continuing to advance rapidly worldwide. Regional needs in the South Pacific for computing professionals (essential for the use of this technology) argue for the highest possible standards of Computing Science education.

Recognising these factors and numerous deficiencies in the computing science courses offered in previous years, the Department of Mathematics at the University of the South Pacific (USP) designed a new curriculum which was approved in principle by its School of Pure and Applied Science Board of Studies in August 1989. This new Computing Science programme is now being implemented and the Department of Mathematics is now the Department of Mathematics and Computing Science to better reflect the mix of courses offered.

This paper describes the design of the new curriculum and the rationale for its development.

Planning the Change

Preparatory work leading to the approval of the upgrading of the curriculum included analysis of the performance of the existing USP programme, reviews of Computing Science Programmes and standards in other institutions and a detailed evaluation of regional needs. For example, the economic incentive for providing appropriate education can be demonstrated by comparing the relative costs of mid-level managerial positions in the private sector filled by an expatriate to that needed to hire and retain a local person (anything up to 4 times as much). It is interesting to note that virtually all the senior management positions in data processing/information services in the region are currently held by expatriates.

The exercise documented here was a necessary first step to ensure that educational resources were well directed to satisfying both exisiting and future needs for graduates in a way consistent with the objectives of the University. As resources dedicated to tertiary education are likely to remain severely limited, it was essential to address the issue of the relevance of the new academic programme. Public awareness of the economic efficiency of a domestic supply of computing professionals would encourage continued support.

Evaluating the training of computer personnel in Fiji and the region

Approximately 1200 people a year receive one or more weeks of in-house computer training by different organisations. Diploma and certificate studies at the Fiji Institute of Technology (FIT) and certificate studies at private business schools satisfy a need for small businesses and routine work but do not qualify for the more demanding positions starting at the programmer/systems-analyst level. Although people are recruited, largely because of their ostensible hands-on skills, they require significant additional training to qualify them for more responsible positions. (There bas been and still continues to be a serious shortage of technically trained personnel due to migration. A significant part of the regional demand for computing personnel is for the replacement of those lost in the so-called "brain-drain").

Essentially all the major employers of computing professionals report that there are two levels of computer employees, senior and junior, and for senior level and other positions requiring extensive technical experience and competence, the predominant source is overseas (Australia, New Zealand, Sri Lanka, etc.). This information comes from a set of interviews with a number of managers of data processing or information services sections of private sector companies or government agencies.*

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* More details are given in a Department of Mathematics and Computing Science Position Paper: "New Curriculum Development and Programme Management for Computing Science at The University of the South Pacific." Where other such additional information is available for related items in this paper, they are marked with "*". The working paper is available on request from the Department.

For entry-level and junior positions, candidates are identified within the organisation for transfer to computing positions or are recruited locally. In both cases, extensive internal training is needed and this is so even when the candidate has a locally acquired degree, diploma or certificate indicating that the training received did not have content fully relevant to regional needs and was not of sufficient academic depth.

Objectives of the New Computing Science Curriculum

In response to an analysis of regional training needs and the current role of USP in computing science education, several broad curriculum objectives* were elucidated. They were:

- The Computing Science curriculum must be consistent with the broad aims and objectives of a university education. This included the need to provide a comprehensive education to prepare graduates for full professional and management-level positions. Graduates should also be qualified for admission to overseas post-graduate courses and programmes in computing science.

- The programme should be responsive to regional needs. This should embody a recognition of the need to foster regional economic growth by the appropriate education of computer professionals.

- The Computing Science staff at the University should be available as a resource base for consultancy, as advisory agents to governments, and to give special (on-demand) training.

- The programme should plan for optimum use of resources (human and other) and should produce qualified graduates in numbers consistent with market demand.

Specific Issues

To develop and implement these new objectives, a number of detailed issues had to be addressed and resolved. First of all, as noted in the introduction, the SPAS Board of Studies approved the new curriculum in principle and allowed for an expansion in course offerings. It was understood, however, that no additional resources would be provided for the implementation of these changes.

The implementation of the new curriculum is consistent with that requirement although the programme would benefit dramatically from an increase in academic resources. The response has been coupled to the availablity and efficient use of existing resources.

Selection

Computing Science classes will be restricted in size to accommodate resource constraints, to provide adequate instruction and to balance regional needs. This will ultimately generate about 20 qualified graduates each year.

In the introductory course MA153 (as described later) grades and aptitude tests will be used to qualify students for admission to the Mathematics degree with a Computing Science major. The likelihood of graduating significant numbers with Computing Science majors will be enhanced by this.

Proficiency

The new curriculum has been designed to develop programming proficiency. (This is a significant advance over providing only a general awareness of programming concepts which was all that was possible previously). Concentration on a single high-level language (Pascal), problem analysis and algorithmic development occurs early in the course sequence. The students will have a limited exposure to FORTRAN, COBOL, and C programming languages; this should be adequate to facilitate professional transition to the use of these languages.

Continuity

The introductory course will be maintained as

- a service course in applied computer skills for other degree programmes, using packaged software;
- a terminal course for basic computer literacy;
- a qualifying course for major studies in Computing Science; and
- the Extension introduction to computers course.

The New Curriculum

The Department of Mathematics and Computing Science offers, as of the 1990 academic year, three possible majors: Mathematics, Computing Science, and Mathematics and Computing Science. The major in Computing Science is made possible by having 6 units (rather than the 3 previously offered by the Department)* in this discipline. For students with a major in Computing Science all six Computing Science courses are required.

Prior to 1990, the 3 units offered provided the students with a total of 168 lecture hours and 43 hours of tutorials. The new programme doubles these figures to about 350 lecture hours and 85 tutorial hours. These hours are low by international standards which are typically in the order of 500 to 650 lecture hours for computing science and 1000 to 1250 lecture hours for computer engineering undergraduates. The new courses do, however, respond adequately to regional needs at this time.

The New Courses

MA153 *"Survey of Computing Science and Information Technology"* - an entry level service course, designed primarily to train users of standard software packages (word processing, spreadsheet, and database). It is also necessary (with aptitude testing) for a degree student intending to major in Computing Science.

MA154 *"Introduction to Computing Science"* - the first computing science course designed to lay the foundation for further studies in this discipline. Problem solving and algorithms are stressed using the Pascal modern high level language.

MA253 *"Data Structure and Algorithms"* - introduces the principle data structures required in the construction of programs for sorting, searching, and string manipulation.

MA254 *"Computer Organisation"* - aims to provide an understanding of current computing equipment and the relationship between hardware and software. It provides a general foundation for further training, particularly for systems analysis.

MA353 *"Software Engineering"* - essential for those intending to become involved in software production. This course concentrates on the techniques and methodologies needed for efficient production of software.

MA354 *"Database Management Systems"* - a foundation for information systems, the largest use of computers in the region.

Implementation

Two basic options for the implementation of the new courses were considered: first, to phase-in the new courses over 2 years as the older ones were being phased-out and second, to offer immediately all 6 new courses with 3 new courses offered in Semester I, 1990 and the remaining 3 new courses in Semester II, 1990.

The first option involved no overlap of courses with the expectation that most students would be completely in one stream or the other. The major disadvantages of this approach were thought to be delay in offering the improved courses to part-time students and a risk that the full implementation of the new courses might be aborted due to uncontrolled circumstances later on.

The second approach, which has been adopted, clearly provided a quicker response to the urgent need for qualified Computing Science graduates. Another practical factor influencing the choice and favouring this option was the short-term availability of a larger than normal number of staff who could support the added work load of the conversion.

Standard aptitude testing* is an essential part of the programme design. It will be used to identify those students likely to succeed in subsequent computing science courses. Only with better and earlier identification of students likely to succeed can class sizes be maintained at levels commensurate with good pedagogical practices and well qualified graduates. Testing provides a reasonable means of controlling class size and composition.

Costs and Benefits of the New Programme

As noted before, the immediate full implementation of the new curriculum will significantly increase the workload of academic staff developing new materials for several courses simultaneously and dealing with difficulties in managing students already partially through their course. This increased workload may be partially mitigated by reduced class sizes (excluding MA153 which will continue to cater for 150-200 students).

From the students' perspective, some confusion is likely to exist for those who have partially completed their course(s). Selection of future courses by students, particularly when they have not completed the new lower level courses which are prerequisites for advanced courses, will be a problem. Some dissatisfaction, even perceptions of unjust exclusion from advanced courses, must be anticipated. Great care will be needed, therefore, to ensure fair and equitable treatment while providing the best and most appropriate educational opportunity for each student.

Balancing needs with available resources, providing a new level of quality graduates, and building an academic programme responsive to and consistent with regional needs means a need for reduced class sizes.

Anticipated Benefits

Anticipated benefits of the new curriculum include:

- The quality of graduates, in each of the three options offered by the Department will be significantly enhanced.
- The numbers of graduates with majors in Computing Science should be appropriate for regional market needs for the forseeable future.
- Maximum use of academic resources will be achieved. No additional funding will be necessary although staff salaries need to be made competitive within the region. The programme would also benefit from a modest increase in other academic resources.
- The curriculum will be consistent with the objectives of a "university education" with a major in Computing Science and it should facilitate the USP graduate's success in more advanced programmes overseas.

These potential benefits will not be realised immediately, although the problems are likely to occur quickly and before any of the benefits are apparent.

Failure to persevere against pressures to reduce the impact of these "problems" could seriously jeopardize implementation.

Some Remaining Issues

A number of significant issues remain to be addressed. Although the concerns described here are not unique to this programme, they are of particular importance when one considers the qualities expected to be developed in the education of computing professionals.

Foremost and most complex among these issues is that related to student attitudes regarding learning and how learning is valued and achieved. Students' concern for grades and qualifications; pressures such as continued financial support; comfort with the memorisation and regurgitation of facts; test anxiety and cheating all need to be addressed.

Computers facilitate mechanical reproduction (copying) of work and this is a particularly difficult problem. Although apologists explain away this behaviour by referring to the "sharing" or "communal" nature of island culture, real costs to the students remain. There appears to be an inadequate appreciation of the fact that such behaviour impedes an individual's true mastery of the material presented, invalidates assessments, differentially penalises the diligent, and perpetuates behaviour which may be socially (if not legally) unacceptable. In order to partially address this problem, a policy on "academic honesty", specifically to clarify the issue for computer related issues, is now under final consideration.*

Another significant academic issue relates to the use of objective standards for testing. In order to ensure and document the attainment of skills and knowledge consistent with international standards, objective testing will be used. This may not be well understood, but it is essential to establish academic credibility in Computing Science. The design of appropriate test instruments will be another challenging task for the staff.

Early intervention in the education process, to enhance the students' skills in problem analysis and solution, is also urgently required. At present, these skills are underdeveloped in most students attempting to undertake Computing Science courses with the consequence that an excessive part of each course has to be devoted to non-content issues.

Concluding Observation

Finally, it must be noted that Computing Science curriculum development and evaluation is not a mature practice. Computing Science as a discrete discipline is too new. New practices are being tried; some successful many rapidly discarded. Until greater resources are available, it is our view that the USP Computing Science programme described in this paper represents the most effective utilisation of available resources and the best response to regional needs for university-educated computing professionals that can be reasonably achieved.