

The Carrick Vision and Computing Education: Four Case Studies in Multi-institutional Collaboration

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Abstract

The Carrick Institute is an initiative of the Australia federal government. It is aimed at generating strategic change in Australian University education, via grants and other awards to approximately \$20 million annually. By previous Australian standards, the potential funding for projects is large. However, the Carrick Institute has a well focused vision, and grant applications need to be aligned with that vision. This paper first describes some key aspects of the Carrick vision, before describing four multi-institutional computing education projects that successfully attracted funding from the Carrick Institute in 2006. Three of the projects are funded under Carrick's Priority Program, and are concerned with different aspects of automated assessment: (1) assessing Unix scripting skills, (2) self and peer assessment in groupwork, and (3) the assessment of novice programmers. The fourth project is funded under Carrick's Disciplinary-Based Initiatives Scheme. Commonalities in the structure of these three projects are observed.

Keywords: Carrick Institute, Assessment, Unix Scripting, Group work, Novice programming, Multi-institutional Collaboration.

1 Introduction

Among its six objectives (Carrick, 2006a) the Carrick Institute lists two objectives of particular interest to potential grant applicants from the computer education community:

- Promote and support strategic change in higher education institutions for the enhancement of learning and teaching, including curriculum development and assessment.
- Develop effective mechanisms for the identification, development, dissemination and embedding of good individual and institutional practice in learning and teaching in Australian higher education.

Among its five values, the Carrick Institute lists three that are of particular interest to potential grant applicants:

- Inclusiveness - by assisting the development of networks and communities which support higher education staff who have a direct impact on the advancement of learning and teaching.
- Long-term change - through a focus on systemic change.
- Collaboration - through the programs it funds and in its work practices.

In this paper, we refer to the Carrick objectives and values – in particular those listed above – as the Carrick vision. In the remainder of this introduction, we interpret that vision from an historical perspective, by describing the factors leading to earlier education funding institutions being succeeded by the Carrick Institute.

From 1993 to 1996, a grant scheme was run by the Committee for the Advancement of University Teaching

(CAUT). It funded 448 National Teaching Development Grants, with an average funding level per project of \$37K (Carrick, 2006b). The scheme emulated the traditional process of research funding, with individual academics competing for funding by submitting proposals for peer review. In 1997, CAUT was succeeded by the Committee for University Teaching and Staff Development (CUTSD), which existed for three years (Carrick, 2006c). As part of its brief, CUTSD ran the National Teaching Development Grants scheme. This scheme offered grants in three categories: individual; organisational; and staff development. In three years of operation, 272 grants were awarded. CUTSD also organised activities, such as annual forums, to encourage dissemination of project outcomes.

CUTSD was superseded by the Australian Universities Teaching Committee (AUTC). In a report commissioned by the AUTC, Schofield and Olsen (2000) were critical of the benefit of CUTSD funded projects beyond the immediate benefit to those directly involved in the projects. In their executive summary, they wrote the following:

“Overall there is a shared perception that dissemination of CUTSD grant outcomes was generally weak ...” [page 4]

“The idea of hundreds of individual grant holders being able to disseminate the outcomes of their work sector wide in the proactive manner required to stimulate adoption is unrealistic. What is needed are high quality professional dissemination mechanisms which build on recognised professional networks.” [page 6]

In the long transition from the AUTC to Carrick, the AUTC provided extensive input into the development of the Carrick Vision. As part of that input, the AUTC commissioned two large studies on the question of how to organize educational projects to achieve effective dissemination (McKenzie *et al.*, 2005; Southwell *et al.*, 2000). In their executive summary, McKenzie *et al.* made a number of recommendations, some of which are of particular interest to computer educators who are potential grant applicants. That subset of the McKenzie *et al.* recommendations are listed below, in the remainder of this section of the paper

Types of projects recommended for funding include:

- Projects aimed at adapting and implementing successful innovations in new institutional and/or disciplinary contexts, in addition to well designed innovation projects;
- Both individual projects and collaborative projects, funded through separate granting pools with a greater proportion of the total funds available for collaborative projects;
- Within the definition of collaborative projects, those involving a lead institution and a set of consultation partners, collaborations involving a small group of partners and cascade models of collaboration.

In relation to application processes:

- [enable applicants to] develop well-designed evaluation and adoption-focused dissemination plans.

In relation to the criteria for assessing applications for funding, include criteria which:

- Emphasise scholarship, particularly in project design and evaluation;
- Emphasise effective evaluation (as described above);
- Require adequate proportions of the budget to be devoted to project management, evaluation and dissemination;
- Require applicants to consider approaches to dissemination which engage potential users throughout development and are focused on the intended adoption, implementation and embedding of project outcomes.

1.1 The Priority and Discipline-Based Schemes

To implement these recommendations, the Carrick Institute has developed several different funding schemes for education projects. Two of these schemes are of particular interest to computing educators as (in 2006) several computing education projects have been funded via these two schemes:

- The **Priority Program** (Carrick, 2006d) has funded three of the projects described below. These three computing education projects were successful in a competitive process against applications across many disciplines. Each of these three projects is intended to run for two years, and each has a total budget of approximately \$200K.
- The **Disciplinary-Based Initiatives Scheme** (Carrick, 2006e, p.3) does not operate under the usual competitive model of academic grant funding. Instead, Carrick identifies disciplinary leadership groups and through a consultative process with those groups allocates funding to support large-scale projects in those disciplines. In the case of computing education, Carrick consulted with several Deans and Associate Deans of Information Technology.

1.2 Overview

The next four sections each describe a computing education project which was granted funding by the Carrick Institute in 2006. The first three sections are the three projects funded under the Priority Program.

2 Assessing Scripting Skills: LinuxGym

Scripting is the “glue” which holds together many different applications in enterprises from banking to genome sequencing. While 10% of all jobs advertised in the IT/Telecommunications sector seek scripting as a skill, it is to the detriment of both industry and education that it has been very difficult to teach and learn.

Developing scripting skills requires consistent practice and feedback. However, with universities nowadays having a large student-to-staff ratio, there is very little scope for providing the necessary feedback, and university degrees have produced only a small percentage of graduates with the necessary scripting skills.

2.1 Prior to Carrick Funding

Prior to the application for funding to the Carrick Institute, Solomon began the development of LinuxGym

and used it to teach and assess scripting skills with students at UTS.

In LinuxGym, a student attempts to write a script with a well specified behaviour. When the student asks for feedback, LinuxGym runs the student's script in several ways to compare its behaviour with what is expected. While this testing does not judge the clarity and maintainability of the student's script, it provides feedback on its functional correctness. In terms of education, functionality is the most time-consuming aspect for teachers to assess. The system therefore enables students to gain considerably more practice and feedback on their skills than would otherwise be possible.

Over the last four years LinuxGym has successfully been used to increase both syllabus coverage and the pass rate of large student cohorts at UTS. The undergraduate syllabus coverage has gone from merely copying and editing files to writing complex scripts, while the postgraduate student failure rate has dropped from its previous level of 30–50% failure to almost zero. Furthermore the marking load of teaching staff has been reduced. LinuxGym has been described in greater detail elsewhere (Solomon, Santamaria and Lister, 2006).

2.2 The Carrick-funded Priority Project

This Carrick-funded phase of the project is led by Solomon, with Santamaria, Kay, Shepherd and Lister as partners. The project thus spans three institutions: UTS, Sydney, and UNSW.

The funding covers three broad types of activities, development, dissemination, and evaluation: These activities are discussed below.

- LinuxGym will be further developed, so that the software is stable, easy-to-use, free, and Open Source. Also, a website will be developed to support the use of LinuxGym by a broader teaching community.
- The Carrick Institute is also supplying funds to build a community of academics and practitioners, beyond UTS. LinuxGym will be introduced to students in four universities across Australia as a sequence of fun certification events (“LinuxGym 101”). These events will be followed by a workshop for lecturers.
- The Carrick Institute is also supplying funds to formally evaluate the effectiveness of LinuxGym, both for students and teachers.

3 Peer Assessment in Group work: TeCTra

The ability to assess the work of others is one of the core skills expected of professionals across many disciplines. Developing this graduate attribute requires the learning by students of self-and-peer evaluation, feedback, and review skills and understandings. Many professionally oriented higher education courses include capstone subjects involving projects that require large student teams. The common assessment strategy for group work of allocating the same mark to all team members is not adequate, as the project tasks are extensive, the teams are large in number (more than 4 members), extend for the whole semester and group work can constitute 100% of the final student assessment. Furthermore, the subject coordinator has limited opportunities to observe and assess the complex group and teamwork dynamics that

are taking place. A peer-assessment and review strategy is required which is ideally formative, diagnostic and summative

3.1 Prior to Carrick Funding

Since 2004, the TeCTra system has been developed and trialed in the Faculty of Information Technology at UTS. In addition to recording time spent on the project by individuals, TeCTra also requires the students to rate and provide confidential feedback on each other's contributions on a weekly basis. The time records and ratings are converted into contribution factors for each week.

Each team member is able to see their relative position in his/her own group in terms of contribution and can take corrective actions. The contribution-factors are also monitored by the coordinator for early identification of non-performers who can be offered timely intervention and assistance. The peer review comments provide valuable and influential qualitative feedback to all team members.

The utility of TeCTra is apparent from a comparison of peer assessment behaviours in students before and after the introduction of TeCTra. In three semesters prior to the introduction of TeCTra (1998-01) students did not have any support in allocating individual marks apart from a set of written rules and suggested practices. In this period between 75-90% of all groups opted to have equal or almost equal distribution of marks within the groups. Such a distribution of marks was hardly plausible as groups of 10 students would rarely be so finely balanced in terms of sharing the group-workload. In three recent semesters (2004-5), with TeCTra in use, only 15-20% of all groups allocated marks almost equally

Over the years the TeCTra prototype design has developed more qualitative and quantitative peer feedback, evaluation, review and assessment capacity. Features to facilitate better communication for non-confrontational feedback, and the visibility of data and processes has dramatically changed the students attitudes to peer-assessment.

Tectra has been described in greater detail elsewhere (Raban & Litchfield 2006a, 2006b).

3.2 The Carrick-funded Priority Project

This Carrick-funded phase of the project is led by Raban and Litchfield, both of UTS. This phase will make the TeCTra-prototype tool available to other Australian Universities through the further development of the software together with an extensive dissemination strategy.

Further development and pilot-testing will occur in five sites involving in excess of 1500 students across UTS (in three faculties), QUT and Curtin. The tool will be extensively trialed, evaluated, and areas for improvement identified. After two cycles of iterative educational-design and improvement, the tool will be packaged as an Open-Source application and disseminated for use in Australian Universities.

4 Assessment of Novice Programmers

The problems of teaching and assessing novice programmers are well known. The project participants are from five Australian universities, all five with a prior record of innovative approaches to assessing the programming skills of students. By combining their existing work, the participants will produce a comprehensive approach to improving the novice programmer assessment experience.

4.1 Prior to Carrick Funding

Two of the participating institutions have built software systems for automatic formative and/or summative assessment of programming. Academics at the other three participating institutions have developed methodologies for assessing novice programmers. These five prior activities are described in the next five paragraphs.

At Sydney University, Kay has explored ways to support reflection in novice programmers. There is a large body of evidence suggesting that learning effectiveness is enhanced when learners reflect on their learning experiences. Kay has developed systems to support reflection. Earlier versions were called “Assess”, while more recent versions have been known as “Reflect” (Kay *et al.*, 2000, 2001, 2002).

QUT has developed two software systems for automatic formative and/or summative assessment of programming. The Environment for Learning to Program (ELP) is an online, active, collaborative, and constructive environment. It provides timely formative assessment by presenting students with fine-grained online exercises and answers for Java and C# programming problems. The other QUT system, called ExamGen, is a GUI-based, stand-alone, Java application, designed for the purpose of managing multiple choice and short answer questions. Both systems have been presented at prior ACE conferences (Truong, Bancroft, and Roe, 2003, 2004, 2005; Rhodes, Bower, and Bancroft, 2004; Woodford and Bancroft, 2005).

At Monash, Carbone has worked on ways of systematizing programming assessment tasks (Carbone *et al.*, 2000, 2001, 2002). She advocates that assessment task should follow her NOCCA ORLA principle (detailed in her PhD thesis), an acronym standing for:

- Novelty, Openness, Complexity, Collaboration, Authenticity
- Ownership, Reflection, Linkage, Assessment

At USQ, de Raadt has studied methods for the explicit teaching and assessment of problem solving strategies, using Soloway’s Goal/Plan approach. He has generated new curricular components and altered the teaching and assessment of students at USQ to incorporate explicit problem solving instruction and assessment based on a Goal/Plan framework (de Raadt *et al.*, 2004, 2006).

At UTS, Lister has studied the program comprehension skills of novices, and applied the Bloom and SOLO taxonomies to structuring assessment tasks for novice programmers (Lister *et al.*, 2001–2006).

4.2 The Carrick-funded Priority Project

The project work comprises four main areas, as follows:

- System Development: The existing systems have been developed for use within their respective institutions. These systems will need to be adapted and generalized to cater to the needs of other institutions.
- Content Development: The participants will pool their expertise in assessment design, to populate the existing QUT and University of Sydney online assessment systems with items developed according to the various assessment methodologies.
- System/Content Evaluation: As the systems are used across the participating institutions, the effectiveness of the systems, and their content, will be evaluated via the analysis of the performance of students, and also via surveys of students and teachers using the systems.
- Dissemination: In the first year, the project participants will go to other universities in their respective cities, and give presentations on the project. These universities will be asked to express interest in eventually using these systems. In the second half of the project, one-day workshops will be held in each of Brisbane, Sydney, and Melbourne, to (1) prepare academics at other institutions to use these systems, and (2) improve the assessment strategies used by those academics. Also in the second year, this project will directly assist other institutions in setting up the infrastructure to use these systems.

5 Disciplinary-Based Initiatives Scheme

Under this scheme, a distinction is made between disciplines that have undertaken prior investigations (Category A) and those that have not (Category B). ICT is one of three disciplines selected in the first round of Category A funding for this scheme

5.1 Prior to Carrick Funding

Category A funding for ICT is largely in recognition of a project that was conducted by the Computing Education Research Group (CERG) at Monash University. In 2001, the AUTC funded a national project (ICT-Ed) that investigated teaching and learning initiatives in the ICT discipline in Australian universities (Hurst, 2001). The project was broad focused, involving a review of research and using a variety of methods to collect data from and about key stakeholder groups in ICT education — educators, students and employers. From this extensive data collection, information was gained about the types of teaching initiatives undertaken by ICT educators, the ICT educators’ perceptions of factors that promote and inhibit innovation in ICT education, employers’ views of the preparedness of ICT graduates for the workforce, and ICT graduates’ perceptions of the value of their courses.

Among key findings of the ICT-Ed project were that ICT educators face many challenges working in a discipline that is fast changing and with increasing pressures to respond to the needs and demands of students, employers and institutions. Educators generally felt that teaching was unrewarded and undervalued, and institutional agendas tend to discourage educational innovation. The educators generally found their students to be conservative and resistant to innovation and change in teaching practice and learning activities. A constant tension they faced was whether to teach specific skills,

which may help students gain employment, or to teach more generic skills from a foundation of principles and theory, which can prepare students better for long term employment and life long learning. The project also found that little is known about ICT graduates' experiences in the workforce and how they perceived their courses.

An outcome of the ICT-Ed project was a set of 12 recommendations for the improvement of interactions with the outside world, the fostering of educational innovation and the promotion of evaluation of teaching and learning initiatives (Hurst, 2001).

5.2 The Carrick-funded Disciplinary Project

Under the Disciplinary-Based Initiatives Scheme, funding for the ICT discipline has been given to a consortium of IT faculties from Monash, QUT, UTS and Wollongong universities, with Wollongong as the lead institution. The project titled "*Managing Educational Change in ICT Discipline at Tertiary Education*" aims to study the nature and dynamics of change in the ICT discipline. This will be focused in the university sector but will investigate the interfaces with the schools and employment sectors. The long-term goals are to identify strategies and develop models to better prepare secondary school students for ICT degrees, further improve the ICT curriculum, build capacity in ICT educators for managing educational change and create better ICT professionals.

The project will be conducted in two stages. The first is a review and scoping stage in which the key issues will be identified and prioritised. This will build upon the work conducted in the ICT-Ed project and other relevant studies. In the second stage, a series of pilot projects will work towards developing a model for ongoing collaborative effort.

6 Discussion

The reasons why these projects were funded are perhaps only known to the Carrick Institute. However, all of the projects share four characteristics, which we the authors of this paper believe implement the Carrick vision:

- Prior work: All projects had a track record in the project area prior to approaching Carrick.
- Multi-institutional: All projects are collaborations that cross institutional boundaries. One of the projects (TeCTra) is also multidisciplinary.
- Formal Evaluation: All projects contain mechanisms to formally evaluate the project outcomes.
- Dissemination: All projects have strategies for spreading the developed systems outside the collaborating institutions. (Indeed, the presentation of this paper at this conference is an early dissemination activity of these projects.)

6.1 The Competitive Grants Scheme

While the three Priority Program projects are funded under Priority 1 of that scheme, each year Carrick targets specific disciplines for funding under that priority. While Computing and Information Science was targeted in 2006, it is not a target in 2007. Thus, these three projects would not have been eligible for funding under the Priority Program had they been submitted in 2007.

However, computing education projects similar to these three projects may be eligible for funding under Carrick's "Competitive" grants scheme, given that one of the priorities of that scheme is "Innovation in learning and teaching, particularly in relation to the role of new technologies".

In 2007, both full proposals and expressions of interest for the Competitive Grants Program are due on April 23. Applicants who submit an expression of interest that is judged suitable are then required to submit a full proposal by August 13. Negotiating and assembling a multi-institutional collaboration is a major undertaking. It would be ambitious to initiate a collaboration after ACE2007 and complete a full proposal by the April deadline. While existing collaborations might aim to submit a full proposal by April, the authors of this paper suggest that participants in a new collaboration consider a two-stage approach, where the applicants first aim to submit an expression of interest, followed by a full proposal.

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