From Problem-based to Studio Learning for Requirements Engineering

By Jocelyn Armarego

Studies of practitioners of software development have resulted in a gap being identified between what students learn in their formal education, and the skills sought by industry.

A study (Minor, 2004) of the model curricula and Bodies of Knowledge (BoKs) on which many university programs in IT are based shows that, in general terms, the base case of discipline knowledge is covered comprehensively. However, non-technical skills are usually addressed at a more abstract level and often in association with ethics, management or social concern, with little assistance provided on how these soft skills should be incorporated within a study programme. Yet practitioner studies indicate they place great importance on these skills – they require personable professionals who integrate into the organisational structure. Industry also looks for graduates who, rather than cope specifically with today's perceived problems, have models, skills and analytical techniques that allow them to learn, evaluate and apply appropriate emerging technologies in a collaborative environment (see, for example Lee, 2004; Macauley & Mylopoulos, 1995).

I wanted to identify what generic and soft skills IT practitioners considered important, and explore how learning models could address them within a tertiary curriculum. Rather than encompassing the broader IT domain (where Software Engineering (SE), Computer Science (CS) and Information Systems (IS) are identified as the more visible disciplines), I decided to focus on Requirements Engineering (RE) (sometimes called system/software analysis), acknowledged as one of the most problematic of the activities undertaken in developing and implementing IT systems. Studies show that the root cause of many of the problems with systems in general can be traced back to RE issues (Boehm, 1981). Examining perceptions of competence in RE could go some way towards addressing these issues.

A preliminary investigation isolated characteristics of the RE discipline on the one hand (identified as complex, cognitive, opportunistic, creative, emergent) and of learning on the other. This suggested that the elements highlighted as either:

- *practitioner* needs (eg generic intellectual abilities and skills such as initiative, ability to deal with complexity and illstructure and organisational (self, task and information) skills; or
- *domain* needs of formal education (eg a focus on flexibility, productive thinking and creativity enhancing activities, and effort spent on higher (metacognitive) learning skills, including abstraction and reflection)

could be best addressed through less traditional approaches to learning, with a focus on advanced knowledge acquisition (Spiro, Feltovich, Jacobson, & Coulson, 1991).

From 1995 to 2005 Murdoch University Engineering (MUE)1 provided a suite of programmes in Software Engineering. The teaching objectives have focused on producing graduates with a special skill in software: we expected our graduates to find career opportunities in both professional engineering industries that have a strong interest in software as well as in IT disciplines. From 2002 students enrolled in the first of the core SE units (addressing RE) participated in an Action Research study that looked at how learning models addressed specific elements drawn from the practitioner studies, and also how they aligned with the students' models of learning and approaches to study. Later work looked at developing a conceptual alignment between the practitioners' needs, the curriculum and the students' learning characteristics.

Kember and Kelly (1993)'s categories of observation techniques informed data collection in order to provide both a qualitative and quantitative perspective (Creswell, 2003) – the latter based on results of instruments surveys and assessment items, the former, of greater importance, based on the students' own words, recorded in reflective components of portfolios, assessment elements and reflective journals, as well as the comments attached to formal (ie University-based) and informal surveys and focus group discussion. These data were the basis of a thematic analysis of student perceptions of their learning environment.

The three cycles of the study (2002, 2003 and 2005) investigated the Cognitive Apprenticeship model (Collins, Brown, & Newman, 1989), a *CreativePBL* model (Armarego, 2005) and finally Studio Learning, which focusses on Schön's (1987) reflecting-in-action. He argued that reflection is central to the ability to act effectively in the unique, ambiguous, or divergent situations that become central to professional practice.

The student perception of these learning environments shows that the success of the specific environment was, to some extent, determined by its alignment to the students' learning approaches:

- students participating in the Cognitive Apprenticeship implementation (2002) were comfortable with the model – as Assimilators and Convergers (typical of engineering) in the main, they expected the teacher to function as a coach. However, they were less comfortable in the *fading* phase of the model – while students were willing to take some control of their learning in a capstone project unit, they perceived that a formal unit should be "taught". In addition, student perception of the learning situation suggested some of the traits of surface learning (Entwistle & Ramsden, 1983).
- the *CreativePBL* model implemented in 2003 addressed the issue of student-centring as early as feasible and focussed on strategies to enhance deep learning. Here students were immersed in a Problem-based Learning (PBL) process - considered an ideal pedagogical strategy for disciplines which deal with illstructured problems. In terms of learning approaches, the shortened version of the Approaches to Study Inventory (ASI) by Entwistle and Ramsden (1983) indicated students were very much sitting on the fence between learning for meaning

(MO) (mean 2.53, standard deviation 0.43) and learning for reproduction (RO) (mean 2.56, standard deviation 0.41). This confirmed qualitative data collected - that as a cohort they perceived that they had learnt neither more nor less from this approach.

Some alignment could be discerned between the tenor of comments made and results of the ASI. In effect, supporting the work of Entwistle and Tait (1990; 1995) meaning-oriented students were more likely to see their learning environment in positive terms while reproduction orientation was associated with the view that the learning environment was difficult.

However, the major issue identified was the fact that PBL is process-oriented, implying process is of greater importance then the product. This raised issues of several types: IT students are very product oriented – they see the artefact (generally the code they develop) as the primary goal of the activities they undertake. Being made to focus on process to (in their perception) the detriment of the product was very frustrating; the dependence on process also had some detrimental effect on the creativity-enhancing environment that had been developed - in theory students were required to follow process stages in sequence, even if the *aha*! factor suggested otherwise. Ultimately PBL was in conflict with the ultimate aim of the intervention – to model professionals in practice.

By 2005 the decision had been made in MUE to migrate all discipline teaching to years 3 and 4 of the BE, and that learning would be based on an adaptation of the environment developed in the SE programme. The benefit to this research was all students were required to undertake an orientation Design Week to facilitate a common understanding of Design Studios and the PBL process. Within the Studio Learning model applied in the SE programme, it was therefore possible to de-emphasise the process and focus to a greater extent on reflection as a strategy to enhance deeper learning. Most students perceived this learning environment favourably (though, as a caveat, they exhibited learning approaches that aligned most closely with the learning model). As one student noted

> I have noticed that the design studios require a lot more work from me than if I was working alone. For example I have to spend more time working on problems because of the extra overhead of working in a team (meetings and social interaction). There is also the need to do extra research to gain information that is normally just handed out in a lecture. However I don't mind putting in the extra effort because I feel the extra effort is worth it because I feel more confident that I do know the material (not an impostor) and can apply it to future situations.

This cohort was observed in their subsequent Studio, specifically the unit where previous cohorts had insisted on being "taught". On this occasion, students exhibited a willingness to work independently, and to vary their interactions (eg teacher explaining, students discussing together, students working individually, etc) depending on the needs of the learning situation, calling on the teacher only as required. Students expressed confidence in their own ability to learn and apply new knowledge as well as adapt what was learned.

An indication of employer satisfaction is provided by graduate career prospects. While empirical evidence is in the process of being accumulated – there are still too few SE graduates to provide statistically significant results, the anecdotal evidence is encouraging. Where one (20%) 2004 graduate Software Engineer was employed by a global software development organisation, of the 2005 cohort 50% (six graduates) are now employed there. Both 2006 graduates (100%) are also with the same organisation, as are SE students who will graduate in 2007.

As we learn more about how students learn, and what they need to learn in order to practice as competent professionals in their chosen discipline, we move further from traditional teaching and closer to the concept of learning as a reflection on professional practice undertaken by both teachers and learners. This view of professional education has implications for the design of teaching (Laurillard, 1993):

- academic learning must be situated in the domain of the objective: the activities must match that domain; and
- academic teaching must address both the direct experience of the world, and the reflection on that experience that will produce the intended way of representing it.

The progression to Studio Learning has been a journey undertaken to empower graduates to be industry-ready IT professionals, and provided learning situations to examine and experiment with theories of action (Argyris & Schön, 1974). For the student, the collaborative nature of the learning environment that has evolved transcends the classroom, fostering self-directed learning and reflective practice that integrates class and work experience. Future research will examine the validity of this perception.

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Endnote

1 The School name has changed several times over the period of the study

Jocelyn Armarego is a Senior Lecturer in the School of IT, Murdoch University and has just submitted her PhD through the University of SA. She has been involved in investigating the gap between practitioner expectations of graduate Software Engineers and their formal education. This has led to the development of several strategies to address these gaps, founded on models of learning that purport to address those elements. Her current research looks to investigating the "success" of those graduates in the profession, from both their own perception and that of their employers.

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Becoming a Tertiary Teacher in New Zealand: Learning in Communities of Practice

By Alison Viskovic

Alison Viskovic, who has been a New Zealand member of HERDSA since 1988, last year completed this PhD study of tertiary teacher development in NZ. It was based on case studies of three institutions: a polytechnic, a wananga (Maori tertiary institution) and a university. A qualitative, interpretive framework was used, and data were gathered from institutional documents and interviews with educational developers and a selection of experienced staff members. The findings showed that most tertiary teachers' learning about teaching and how to teach was in-service (on-the-job), mainly informal and experiential, and the knowledge gained was mainly tacit and process-oriented. Although that was complemented by varying amounts of formal learning, gained through courses or professional development activities, few tertiary teachers had sought or gained teaching qualifications. While institutions had central policies and procedures to support in-service teacher development, their implementation was often uneven. Differences of practice were observed both between institutions, and between departments within institutions, indicating the importance of context for teacher development. The literature survey also showed that few studies of tertiary teaching and professional development had linked teachers' workplace learning with the concept of learning in a community of practice.

It was concluded that, since informal workplace learning was likely to continue to be the mainstay of tertiary teacher development, it should be refocussed and approached from a fresh angle. The concept of *situated learning in a community of teaching practice*, based on the work of Wenger (1998), was used to propose a framework for integrating various forms of support for tertiary teachers. Recommendations for strengthening teacher development focused on three levels: institutions (as social learning systems); communities of practice within those institutions (such as departments, discipline groups, programme teams or campus whanau); and individual teachers (whose teaching identities develop within those communities). A key recommendation of interest to HERDSA members was that, while central courses (often leading to teaching qualifications) should be maintained, educational development units should give more attention to decentralised ways of supporting the informal learning of groups of teachers in their local communities of practice.

An article based on this work has been published in the *Journal of Vocational Education and Training 57*(3), 2005 ("Community of practice" as a framework for supporting tertiary teachers' informal workplace learning, pp. 389–410) and a second article is to be published in HERD, *25*(4). Alison has also presented related papers at HERDSA conferences over recent years, and is about to start a follow-up case study focusing on newly appointed teachers and heads of department. She would be very pleased to hear from other HERDSA members about examples of informal teacher support in their communities of practice.

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Alison Viskovic has been a member of HERDSA since 1988. She was involved in academic staff development at Wellington Polytechnic from 1981 to 1999, and was programme leader of New Zealand's first BEd for tertiary teachers from 1995 to 2006. In 1999 the Polytechnic merged with Massey University, and the degree continued to be offered from Massey's College of Education. Alison retired from Massey in February this year, and has since been working part-time at Whitireia Community Polytechnic, teaching in DipALT and doing a research project on RPL processes.

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